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the glass industry

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OGDEN PUBLISHING COMPANY 55 WEST 42nd STREET, NEW YORK 36, N. Y.

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Midwest Representative: Macintyre-Simpson & Woods
Chicago office: 75 East Wacker Drive
Cleveland office: 1900 Euclid Avenue

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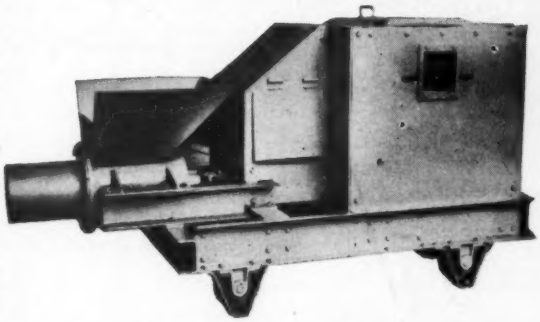

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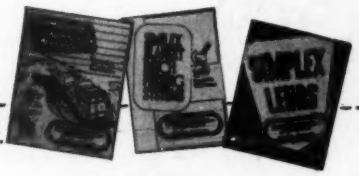

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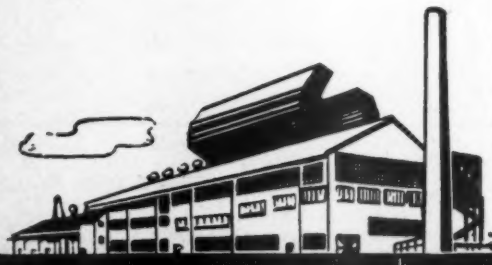

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the glass industry
VOLUME 36, NUMBER 11, NOVEMBER, 1955

Vendor-Consumer Relations

A. P. STERGION, Manager Quality Control
Corning Glass Works, Corning, New York

● IT WILL BE MY PURPOSE to discuss here my company's experience with a management tool which we think offers great promise to business and industry generally. I shall talk about a by-product of quality control, that is, "*Vendor Certification*," and discuss how it tends to build up the desired friendly vendor-consumer relations.

For a company to build a top quality product it must hold to high quality standards. A company's success depends upon it. But turning out a top quality product involves more than just building quality at each step in its manufacturing process. In other words, a high quality product, economically produced, must start with uniformly acceptable raw materials and incoming parts.

Since a major part of Corning Glass Works' sales is in the form of raw materials and parts to our customers, we realize that our future depends on the continuing success of such customers as well as our ability to meet all types of competition. We must continue supplying to our customers a high quality product which can satisfactorily be used in their manufacturing processes.

To do this most effectively, Corning Glass Works must have in operation a "*statistical quality control program*" which embraces much more than just good inspection or quality control techniques in our plants. Such a *program* must eventually develop a procedure by which the customer-user is continually assured of a product whose quality is at a level which he reasonably expects. "*Vendor or quality level certification*" very aptly defines such a procedure, which, in my opinion, is a powerful tool in the promotion of mutual understanding and the merging of aims and purposes between ourselves and our customers.

Looking back and reviewing the methods we have been using while developing our "*quality control program*," I can see the pattern that we have been following. It seems that our *program* can be divided into three phases. I'll briefly explain each of these phases and at the same time mention a few examples.

Our first phase was the introduction of statistical quality control in our plants. This involved the installation of procedures which (1) reduced inspection costs; (2) routinized inspection operations; (3) introduced quality uniformity not only into our own incoming raw materials, but also into our finished products; and (4) provided information for production which could be used to improve quality and thus ultimately reduce reinspection and scrap. The transfer from product control to process control followed with the introduction of control charts at various stages of our processes, both in the fabrication and assembly. Our control chart techniques brought the inspection function right to the production machine. Hour by hour the production men knew the quality of their products. Our scrap, reinspection, and customer complaints have been drastically reduced. Schedules are easier to maintain. Production and inspection people are working together as a team.

The first phase of our *program* will never end because I am sure that there are many more refinements that can be added. A big area is beginning to open up in the statistical design and analyses of research experimentation. Not going to any detail at this point, there are many examples which indicate that the benefits from such a *program* have been great in our company. However, I strongly feel that the greatest progress that we have made has been in our relationship with our customers. This leads us into our second phase which can be called "*customer satisfaction*."

Preparing for and carrying out the "*customer satisfaction*" part of our *program* was done in six major steps:

(1) Meeting with customers on a periodic basis and

Presented before the 1955 Conference on Quality Control, Rutgers University, New Brunswick, New Jersey, on September 10, 1955.

discussing our respective quality and engineering programs for the good of both.

(2) Reviewing very carefully all specification limits and changing them wherever necessary to make them as realistic as possible.

(3) Establishing what is of importance to the quality of the end product.

(4) Classifying quality characteristics into critical, major and minor.

(5) Correlating inspection practices, standards and gaging.

(6) Introducing for the first time in our industry a quality level concept, that is, one acceptable to our customers and one attainable by Corning Glass Works. At the same time, establishing tentative acceptance quality levels.

It can easily be seen that this phase of our *program* is a very important one and one that requires mutual concentration on the things which most vitally affect quality. As a starting point, it was necessary for us and our customers to get together on a periodic basis and to discuss mutual quality problems for the good of both. In the past, visits to our customer plants by our quality control personnel were made only when a quality problem arose requiring immediate action. During such visits not enough time was available to discuss long range quality problems, and, as you can well imagine, it also was not the appropriate time for such discussions. What we did was to initiate regular, formal meetings with our major customers about twice a year, with the sales, purchasing, staff quality control, plant quality control and plant production departments being represented. Although difficult at times, it was our policy not to discuss in these meetings minor quality problems, which could easily be handled by the respective plant quality control personnel, but to discuss both engineering and long range quality-improvement problems, such as indicated in the other five major steps listed above. Another reason for such meetings was to keep abreast of our customer problems and processes because we realize that they also do not stand still and what was good yesterday may be subquality today. Not only do speeds of their processes continually increase, but also new manufacturing techniques are introduced, thus necessitating a possible change in the importance of certain quality characteristics. A most important reason for this type of meeting is to make the customer realize that we are sincerely interested in his problems, that we want progress in quality and that we want him as a team member in attaining such progress. In between these meetings, our plant quality control personnel visits our customer's plants on a monthly basis and constantly reviews the progress.

We soon discovered that statistical quality control was new to many of our customers. As they became more interested and as we learned more about it, we passed our knowledge on to them. In several of our customer's plants, we have not only helped them in the setting up of their quality control departments, but also initiated them to the inspection of our incoming material, as well as to the use of control charts, sampling plans, etc. We realized that, selfishly but realistically, we could perhaps help ourselves by helping our customers if there is any way that we can help them produce better quality at lower cost; that Corning Glass Works will profit thereby.

In the early stages of our meetings with the customers, Step No. 2 constituted the major part of our agenda. We realized that the specifications used by purchasing, vendor, and receiving inspection should be identical. Uniform requirements for each of the three parties involved go a long way toward eliminating misunderstandings.

Secondly, the specifications should be as realistic as possible. By this we mean that tolerances should not be unnecessarily tight—should, in so far as possible, be realistic and reflect the minimum requirements dictated by the use of the item. Unnecessary requirements are bound to lead to higher prices and, in some instances, rejection of material that can be used. It is in this field that the quality control engineer can do a lot to improve vendor-consumer relationships. As an example of this, let us take an article produced by one of our plants at speeds in excess of 1,000 per minute. One of the specification requirements was that the out-of-round should not exceed 0.018". For months our plant absorbed high shrinkages internally in order to meet this requirement, and at the same time, our major customers were rejecting about 10 per cent of our ware for this one defect alone. This condition definitely was not improving the relations with our customers. We finally prepared a comprehensive report showing what our monthly losses were, what per cent defective was involved in the rejected lots, what we had done to try to meet the specification limit, etc., and presented this report to one of our major customers in one of our quality-engineering meetings. We also indicated that the overall quality of the product was being affected because the operator, in trying to meet the out-of-round specifications, was constantly making changes at this machine which prevented his producing a more uniform product for the other more important characteristics. It was our feeling that if he could forget about out-of-round and concentrate on the other characteristics, not only would a better product be manufactured, but even out-of-round would be improved.

At this time, we introduced a new concept in our relationship, that is, we asked our customer if we could run a control test in their plant to determine a realistic specification for out-of-round, that is, at what value would our customer begin to experience additional shrinkage due to that particular characteristic. To make a long story short, the results from two independent statistically controlled tests indicated that a specification limit of 0.026" was more realistic, since no significant increase in shrinkage was noted when ware with out-of-round up to 0.026" was used. In view of this, we asked for and received a temporary specification of 0.026" for six months. Suffice to say, our shrinkage decreased, our cutomer rejections went from 10 per cent to almost 0 per cent, and, according to our customers, the overall quality of the item in question definitely improved. Eventually we were able to meet the original out-of-round specification limit of 0.018" mainly because our operators did not have to *fight* their machines.

The above was an example of a relaxation in specifications, numerous other problems brought up in these meetings eventually resulted in a tightening of specification requirements and to better vendor-consumer relations.

The most difficult part of this phase of our *program* was the establishment of what is of principal importance

(*Continued on page* 596)

Thermal Transmissivity by Radiation in Glass Furnaces

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Acknowledgment

I wish to express my gratitude to Dr. Marianus Czerny, Head of the Physics Department, University of Frankfurt am Main, and to his collaborators, for authorizing the present discussion of their important publications. Further, I am thanking the editor of the Glastechnische Berichte in Frankfurt am Main for his kind permission to use the many illustrations reproduced in this article.

W. E.

The conditions of thermal emissivity from the refractory material of the roof and from the walls of a glass furnace and related industrial kilns have been discussed in the excellent paper of Michaud.[1] We have seen that refractory materials of oxide or silicate composition, as a certain approximation, may be treated as opaque bodies of non-black-body emission characteristics. But the particular effects of a reduction of the grain size in the refractory material, on the other hand, indicated a systematic approximation to the emission qualities of translucent and even of transparent bodies which, in the case of simple oxides and of mono-mineralic silicates, would mean the mono-crystalline material with its entirely different thermal characteristics. For oxides, like alumina, silica, thoria, magnesia, lime, all of which are excellent refractories, we know that they behave as selective radiators, i.e. as bodies which have in the infrared wave-length range (less frequently in the visible range), distinct maxima of absorption, and therefore also maxima of selective emission. In other words, their infrared absorption and emission spectra show more or less sharp individual peaks, or even complicated groups of peaks with a "fine structure." The influence of this phenomenon on the thermal properties of a transparent material, either of a crystalline or of a homogeneous-glassy nature, must therefore be of the highest importance for the glass technician who studies the heat transfer conditions in a given furnace, with given refractory walls, and a given glass composition, i.e. with a particular spectrum of absorption and emission.

We are not able to discuss this interesting problem of the properties of a mono-crystal in the infrared range with the broad details which are the basis of the illumination industry, in the quality of selective radiators. They have been discussed especially well by Fr. Skaupy and his collaborators for "white oxides"[2]. But it is a fact that glass, which is normally understood as a transparent body, judging from the conditions of visible light, must not be and really is not the same in other fields of radiation waves. The practical problem in the thermal behavior of a large mass of fused glass in a furnace tank as a "bath" of e.g. 3 feet depth, in average, is how the transfer of heat in the form of irradiated energy from the refractory material of the furnace roof and walls is taking place. This is, by no means, an elementary problem of physics because we have to consider not only the conditions of absorption in the glass, but also the transmittance to the bottom parts of the tank, and the reflectance on surface boundaries, especially from the "mirror" of the melt, and from the refractory bottom under the bath.

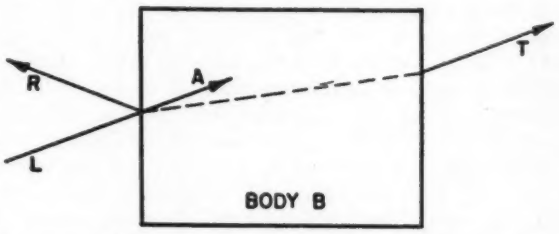


Fig. 1. Radiation Energy Distribution in a Transparent Material (after T. R. Harrison, Journ. Opt. Soc. Amer. 35. 1945. p. 707. With the permission of the American Institute of Physics).

Let us consider with T. R. Harrison[3] the conditions that the energy impinging on the surface of a transparent material (Fig. 1), L, is partly reflected, the portion of L in the reflected energy being R. On the other hand, portion A is absorbed, another portion enters the glass melt, obeying Snell's law of refraction, and leaves it with the energy T. One further defines the reflectance, r, as the ratio R/L, and the absorptance, a, as the ratio A/L, the transmittance, t, as the ratio T/L. If we define in the same way we have done for emissivity[1], by the suffixes t and λ the "total" and "monochromatic" (or spectral) portions of L, we derive the fundamental conditions $a_t + r_t + t_t = 1$, and $a_\lambda + r_\lambda + t_\lambda = 1$. For a_t and a_λ we may substitute, following Kirchhoff's law, the emittance of ϵ_t and ϵ_λ. This means that from a layer of the depth, d, below the "mirror" of the glass melt, radiant energy will be emitted back in direct relation to the absorption coefficient, k, of the given glass. Since this coefficient is in a high degree dependent on the wavelength of the radiation absorbed and emitted, a very complicated effect must be expected for measurements of the radiation energy leaving the "mirror." This means, however, that measurements of the true temperature by optical and radiation pyrometers are not easily corrected for the temperatures indicated by the instrument. It

must also be considered that the energy emitted from a layer in the depth d suffers some absorption on its way through the intervening mass of glass. A fraction of the original energy emitted reaches the surface which is given by a factor e^{-x}, with $x = k_\lambda.d$. From such a formula, which assumes the validity of the Beer law for the system in question, we may therefore determine the depth from which, e.g., half of the energy, or practically no more than, say, less than 1 per cent, of the absorbed energy reaches the surface by emission from the interior of the glass. Only the layers above the limit depth will then contribute to the entire radiation from the mass of the glass melt. This calculation, however, cannot be used for the total radiation, absorbed and transmitted. because the Beer law is not strictly valid for the energy integrated over a wider range of wave lengths, with an individual absorption spectrum of the given glass.

This rather complex aspect of the problem of the accurate determination of temperatures by optical pyrometry from a heat-radiating and visible light-emitting glass melt surface would be hopeless if some conditions at least could not be discussed as to a relatively tolerable approximation, e.g. the condition for the wave length of the filter used in the instrument for which k_λ is relatively small, i.e. for great depths of the glass bath. As filters, in this understanding, may act not only the well-known standard filters for red ($\lambda = 655$ mμ), and green ($\lambda = 550$mμ) in the usual pyrometers, but also the glass material of the optical lenses used. It makes some difference whether the lenses are made of silica, or Pyrex brand, or of ordinary optical glass. In the first case, we have a good transmittance up to 3.8 μ, for Pyrex brand glass only one up to 2.6 μ, and for ordinary glasses even shorter limits, because of the great absorption effects of smallest amounts of FeO, with its peak of absorption at about 1 μ.

It is important to know, from general experience, that many glasses are good emitters in the longer infrared waves which are transmitted by silica glass. Some other glasses, however, are rather bad emitters, even below 2.6 μ, which is the limit transmittance range of Pyrex brand lenses. The large mass of the glass bath will emit radiation from considerable depths for these wave lengths, of which the absorption coefficient, k_λ, is relatively small, and for these the use of a pyrometer with a Pyrex brand lens would be preferable. But the depth required for the limit of entire radiation may be so considerable that the available space is not sufficient. In this case, it is preferable to include radiations into the measurement nearer to the surface mirror, with higher absorption coefficients. For such measurements, the use of a silica glass lens would be necessary in the given pyrometer. In the wave lengths from 2.6 to 3.8 μ also a considerable portion of the blackbody radiation of the system glass melt + furnace walls and bottom would be included in the measurement. But generally only for complete "opaqueness" of the glass melt in question the absorptance a_t and the emissivity ε_t equals unity minus the reflectance, r_t. For the latter the infrared reflectance = 0.04 may be assumed; more accurately the reflectance should be determined by the function

$$\rho_\lambda = \left(\frac{n-1}{n+1}\right)^2$$

but for many practical purposes $\varepsilon_t = 0.96$ is sufficient for an approximation of blackbody radiation conditions.

If, on the other hand, the glass melt is transparent for radiation emitted from the bottom of the tank, and this

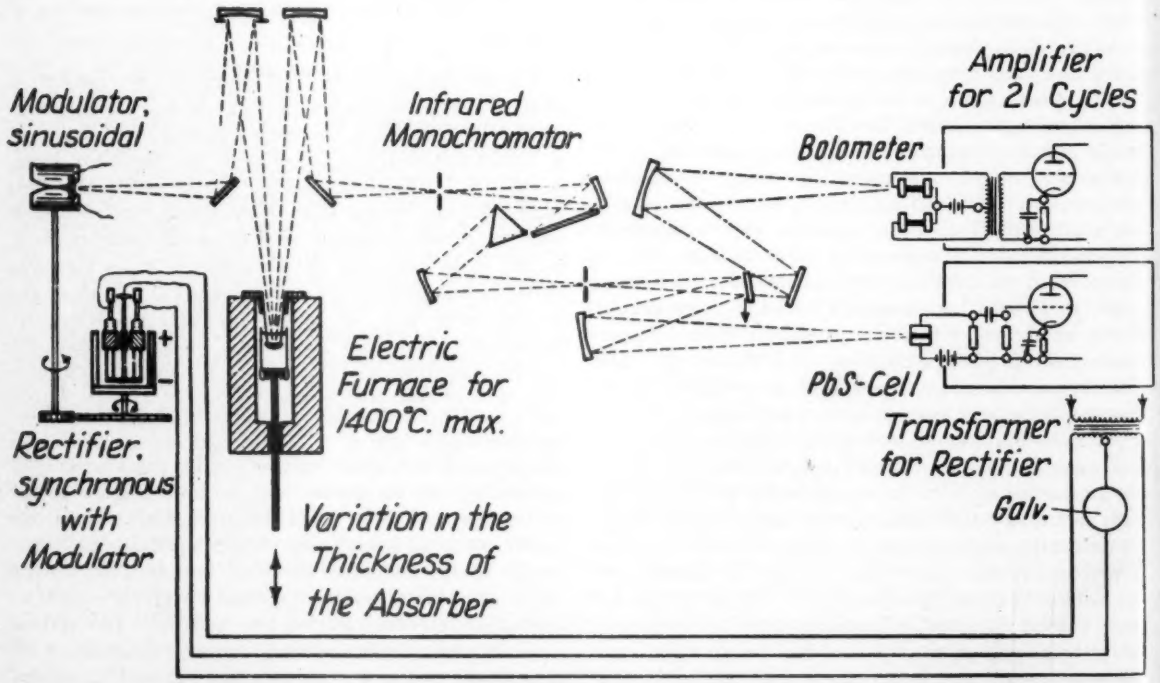


Fig. 2. Schematic Drawing of Infrared Absorption Apparatus with Sinusoidal Modulator. (After L. Genzel).

radiation can enter the measuring instrument (pyrometer), the indicated (apparent) surface temperature is determined intermediate between that which the glass would emit from a sufficiently thick layer (with the absorption coefficient k being relatively small) and the brightness temperature of the material of the cooler bottom parts of the tank or crucible. In other words, we may never have results corresponding to the true temperature of the glass. A total radiation pyrometer with a silica glass lens would be the adequate instrument, but it must be calibrated for the actual plant-operating conditions, i.e. by a comparison with the indications of a thermocouple which is introduced in the melt. This item is also particularly important in every case when the glass is not standing in the tank in considerable depth, but only in the pocket of a relatively shallow level, e.g. in a feeder. In this particular case, a thermocouple should be introduced in the glass at the same point onto which the total radiation pyrometer is directed. The readings of the electromotive force of the thermocouple will be the basis for this calibration. The tank glass in a thick stagnant layer, however, is better tested in its temperature with a total radiation pyrometer with a Pyrex glass lens, because the deeper layers are accessible for visualization with the instrument for a wave length range with considerably lower absorption coefficients, k_λ.

The problems involved by the infrared absorption of glasses as a function of temperature and chemical composition, especially the effects which certain "coloring" oxides and ions really have in the structure of glass and how they influence the optical properties, made an extensive study necessary. We are fortunate enough to dispose here of a valuable recent material collected in publications of the Department of Physics of the University of Frankfurt am Main[4], which may be discussed here in some details. M. Czerny and L. Genzel[5] used in their measurements of infrared absorption in glass melts up to 1400°C. a method whose principle is so ingenious that it may be described briefly (Fig. 2). The radiation proper of the glass melt, as the absorbing medium, is separated from the energy of the light source by modulating the latter periodically before it enters the glass. This is done by a "modulator" device with a rotating sinusoidal slit. The receiver of the radiation then records a mixture of modulated and unmodulated radiation which is transformed to electrical energy, viz. a direct current—corresponding to the radiation proper of the glass melt—and a superimposed alternating current—corresponding to the modulated energy. If the separation of the components is accomplished, e.g., by a transformer, the measurement of the alternating component will almost completely eliminate the effects of the radiation proper of the glass melt on the receiver. The sensitive receiver of the infrared radiation was a bismuth bolometer of low inertia, and a lead sulfide photoelectric cell, whose response, by electronic amplifying, was measured with a considerable accuracy, as well at high as at low temperatures, and up to 3μ wave lengths. As light source, rich in infrared radiation, either a Nernst glower or an electrically heated infrared radiator of silica glass was used. The photoelectric cell was sensitive enough to indicate a radiated energy of only 5×10^{-9} Watts/cm^2 for a wave length of 1.7μ. The infrared radiation of the glass melt in the crucible in Fig. 2 is reflected from a platinum 30 per cent rhodium alloy mirror into a quartz spectrometer, which was used here as the monochromator. The mirror is submerged in the glass melt to a depth which can be controlled in the electric furnace by a micrometer screw mechanism. This way, the depth of the absorbing glass layer can be varied in a precisely measured range. The reflection at the surface of the melt was also corrected.

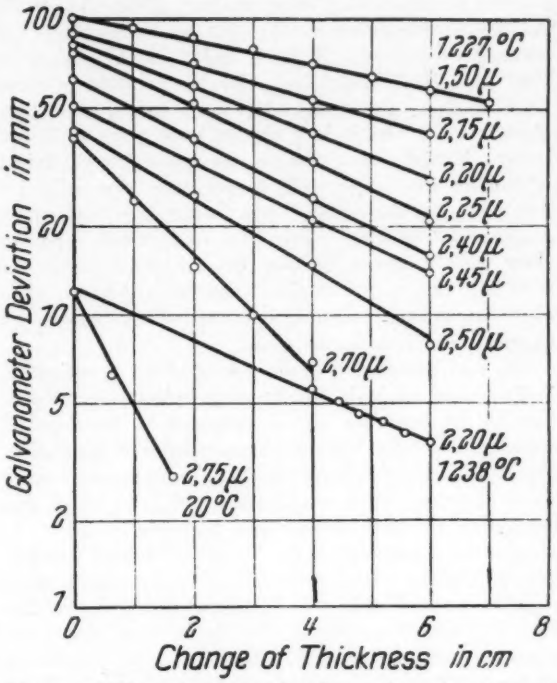


Fig. 3. Validity of the Lambert-Beer Absorption Law for Monochromatic Infrared Radiation (Genzel).

Measurements were first made with different optical glasses (from Schott & Genossen). By the controlled depth of the absorbing layers of the melt the correctness of Lambert and Beer's law for monochromatic radiations was fully established (Fig. 3). The absorption coefficients for wave lengths between 1 and 2.8μ were determined up to 1360°C., the absorption curves given for 0.3 to 2.8μ. The strongest change in the absorption is observed in the range between 500° and 600°C., i.e. in the transformation range of the glass in question. The shifting of the absorption bands ($\Delta\lambda_T/\lambda_0$) with increasing temperature is a characteristic function of the atomic structure of the glass, and may be compared with that observed in the ionic structures of alkali halogenides (in KJ it is 16.2 per cent at 500°C.) The final softening temperature of the glass, i.e. its transition to the thin-fluid state, (in the special case it was 1100°C.) is slightly indicated by an effect on the curves showing the absorption coefficients as a function of temperature, for wave lengths between 1.30 and 2.10μ (Fig. 4).

The results of Genzel were extended by N. Neuroth[6] who studied four commercial glasses of more or less ironcolored types, and one glass rich in PbO (61 per cent), for X-ray protection purposes. The great differences in the absorption coefficients below and above the transformation range are particularly significant for

window glass, and also important enough for the lead glass (Figs. 5 and 6). In the liquid state, the absorption in the glass is increasing with increasing temperature. In general, increasing temperatures bring about a distinct flattening of the absorption bands and edges in the spectra (Fig. 7). Quantitative changes in the absorption characteristics are particularly marked in the neighborhood of absorption bands, but the shifting, $\Delta\lambda_T/\lambda_0$, is usually low. The effects in the softening range and the transformation range are very distinct in glasses colored by chromium oxide, and by iron sulfide (in amber-brown glass) (Figs. 8 and 9, with minima at 790° and 710°, respectively, for the constant infrared wave lengths). The strong effect in the chromium silicate glass is easily visible in a change from green to brown colors. At higher temperatures the absorption coefficient is rapidly increasing with temperature, especially for $\lambda = 1.1\mu$, and the original green color, only intensified, reappears. The glass colored by iron sulfide does not show such a strong increase in absorption above the softening range. Irreversible changes, which are often observed in such measurements, are always caused by chemical reactions in the glass.

The real importance of the results of the investigators in Frankfurt am Main for the glass industry is not only seen in the fine data on the influence of the chemical composition on the infrared characteristics of absorption. From a practical viewpoint they have become much more important by a combination with a thorough discussion of the heat transfer and heat flow problems in glass melts, especially in the "bath" of a tank furnace. This part of the whole problem has found a mathematical solution by A. Walther, E. Eller and J. Dörr[7], and has been ingeniously combined with the infrared absorption measurements of Czerny and Genzel[5,8]. The integration of the "global" transmittance of a given glass at high temperatures over the visible and the infrared ranges, and its combination with the radiation law of Stefan and Boltzmann, was made already by Czerny and Genzel. They had the remarkable result that the depth, z, of the bath to which the diffuse thermal radiation from flame gases of the furnace atmosphere enter, can be calculated, i.e. the "primary" transmittance is determined. The chief difference from the previous calculations of a radiation entering the glass in a direction perpendicular to the surface, which is expressed by the equation

$$Dg = \frac{\int_{\lambda=0}^{\lambda=\infty} E(\lambda, To)\, e^{-k(\lambda)z}\, d\lambda}{\int_{\lambda=0}^{\lambda=\infty} E(\lambda, To)\, d\lambda}$$

is now the application of a *diffuse* irradiation for which a graphic distribution of the global absorption (or transmittance), as a function of temperature, is possible[9]. The "global transmissivity" is then approximately a material constant of the given glass if, at least approximately, the absorption is that of a gray body. For a window and green bottle glass the calculation was performed. For the first type Czerny and Genzel[10] demonstrated that in a depth of 3 to 6 cm already the impingent energy radiation is reduced to 10 per cent of its original amount, while in the green-colored glass the same takes place already in only 4 to 6 mm depths. The steep decrease of the radiation energy in the upper layers is particularly striking and combined with a sudden increase in the absorption above 2.8μ wave length, corresponding to the strong absorption peak of silica. In addition, the green bottle glass has the very intense absorption of ferrous oxide in the short range of infrared which makes the steep increase in the longer wave absorption of silica more diffuse, especially if the temperature is high. In this characteristic, green bottle glass is approximately even a "gray" absorber. The "global transmissivity" is defined for the transfer of heat energy from radiation flame gases, and assuming black radiation on the upper boundary surface

$$D_{g1}{}^{*} = -\frac{2\pi n^2}{\sigma T_0{}^4} \int_{\lambda=0}^{\lambda=\infty} E_s\,(\lambda, T_0)\,.\,K_2{}^{*}\,(k(\lambda)z)\,d\lambda$$

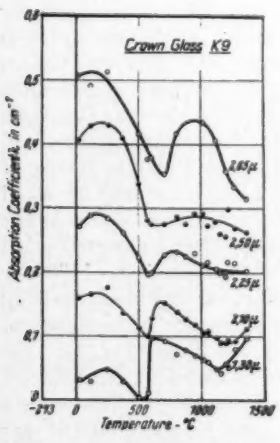


Fig. 4. Infrared Absorption of Crown Glass, as a Function of Temperature. (Genzel).

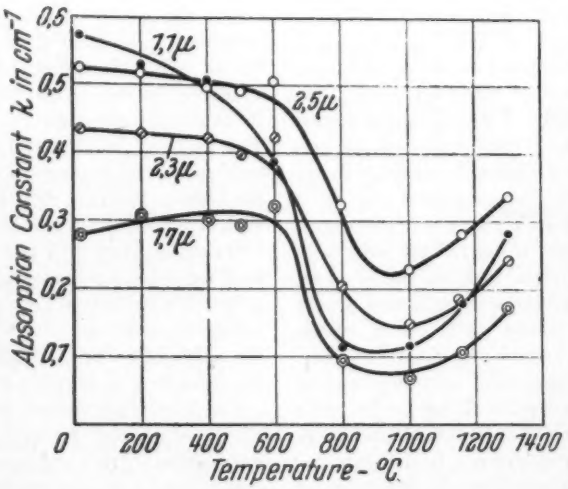


Fig. 5. Infrared Absorption of Window Glass, as a Function of Temperature. (N. Neuroth).

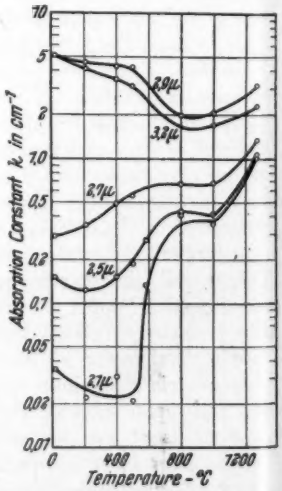


Fig. 6. Infrared Absorption of Lead Glass (for X-ray Protection), as a Function of Temperature (Neuroth).

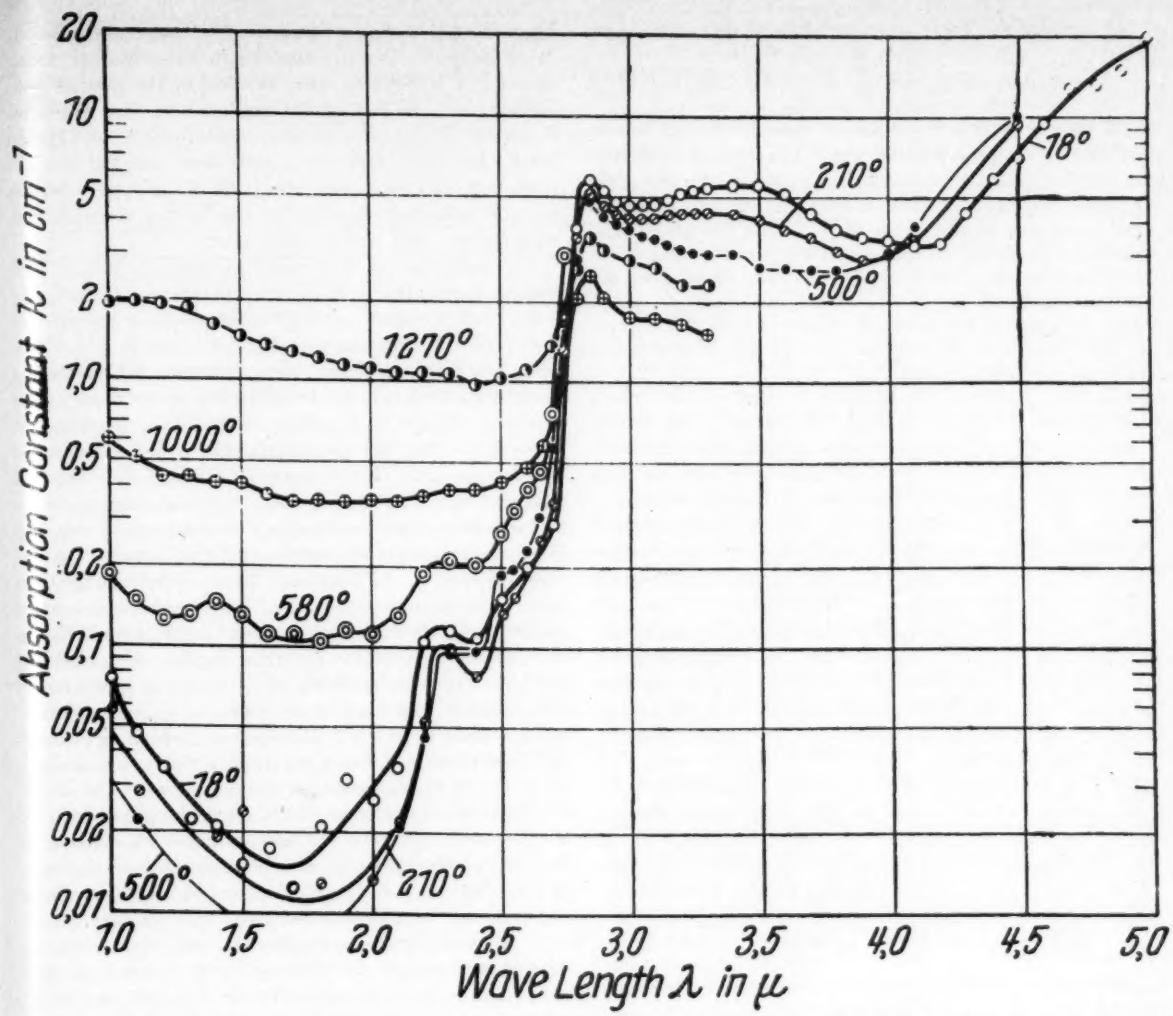


Fig. 7. Infrared Absorption of Lead Glass (same as in Fig. 6) at Variable Temperatures, as a Function of Wave-Lengths. (Neuroth).

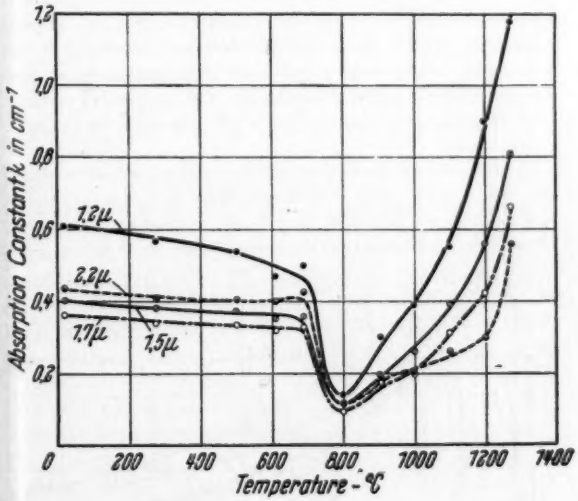


Fig. 8. Infrared Absorption of Chromium Oxide-Colored Silicate Glass at Variable Wave-Lengths, as a Function of Temperature. (Neuroth).

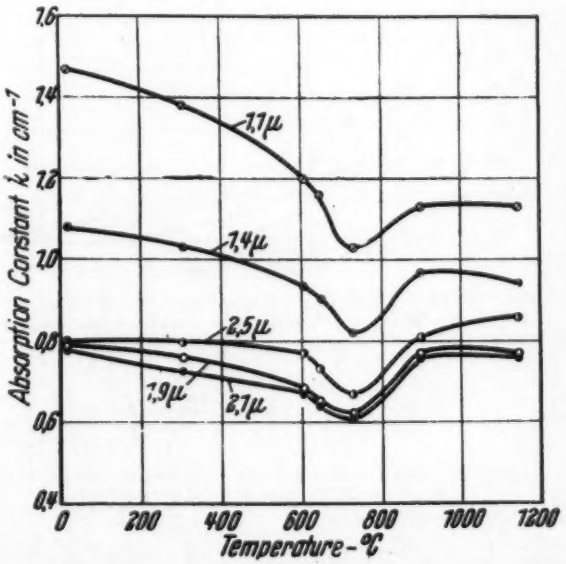


Fig. 9. Infrared Absorption of a Brown Glass at Variable Wave-Lengths, as a Function of Temperature (Neuroth).

(1) and for the lower boundary face of the glass

$$D_{g1} = -\frac{2\pi}{\sigma T_0^4} \int_{\lambda}^{\infty} E_s(\lambda, T_0) \cdot K_2(k(\lambda)z)\, d\lambda$$

(2) which contains the radiation share of the hot bottom refractory material of the tank. The typical difference of the forms of both equations is explained by the jump of the optical refractive indices, from $n \simeq 1$ in the radiating gas, to the value of $n > 1$ of the glass. The practical meaning of the equations for D_{g1} and D^*_{g1}, will be illustrated by Figs. 10 and 11, which give the global transmissivity for the two glass types discussed here, and the approximation equations with the characteristic functions K_2 and $K^*_2(x)$ of the mathematical theory (see Tables 1 and 2).

If this discussion is extended to that of the whole energy flow in the glass bath of the tank, the theory comes to tremendous mathematical difficulties, because the total flow, F, must be distributed over not less than five shares, namely (1) the share of pure heat conduction, (2) that of radiation originating from the half space above the test plane, (3) the share of radiation from the lower half space below this plane, (4) the share of radiation originating from the upper, (5) the portion from the lower boundary face of the glass bath, and which passes in both cases the test face either directly, or as reflected radiation. The solution of this complex problem is necessarily combined not only with the knowledge of the optical properties of the transmitted material at a given temperature, and of its boundary faces, but also with a knowledge of the exterior medium, and the temperature distribution in it. The radiation of the exterior medium is calculated as that of a blackbody of the temperature determined on the upper boundary face of the glass bath. A great difficulty is also the introduction of the temperature gradient on the lower boundary face (the bottom refractory conditions), which cannot be omitted if some approximation to practical conditions is desirable. It is also somewhat bold,—although necessary for a reasonable simplification of the problem—to assume that the boundary face may be free from reflexes for all the wave-lengths impinging, i.e. an "ideally black" boundary face. It is fortunately not too troublesome that the temperature effects on the refractive indices are not sufficiently known, but the lack of accurate heat conductance data is very important.

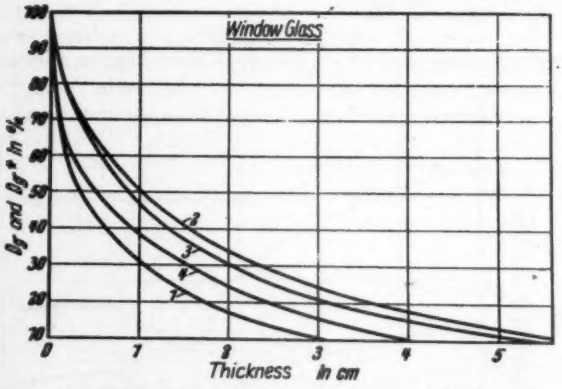


Fig. 10. Global Radiation Transmissivity of Window Glass (Refractive Index n = 1.52), as a Function of Thickness. (M. Czerny and L. Genzel).

The solutions of the combined heat conduction and radiation transfer in glass melts given by Czerny and Genzel are in some analogy with previous attempts of I. Peychès[11], G. Ribaud and E. Brun[12], and B. S. Kellett[13] who, however, simplified the calculation by discussing the energy flow only in the direction of the temperature gradient, and not as a problem of a diffuse dispersion of the energy. Also the measurement of a thermal diffusivity, i.e. the total heat transferred by both true conduction and radiation in centripetal direction from the walls to the center of a glass melt in a cylindrical crucible, follows the principle of one-dimensional transfer. A. F. Van Zee and C. L. Babcock[14] have solved the problem by a most ingenious method of a sinusoidal temperature variation which was superimposed on the mean temperature of the glass melt; the time lag for the sinusoidal heat wave to travel radially to the center is measured in this method. The integrations given by Czerny and Genzel are strict over the half spaces concerned for the ingredient shares of the total energy flow (see above). In place of the exponential functions, here the K(x) functions are introduced which are accessible to graphic and tabular evalutions. The way given for the calculation has also some similarity with astrophysical problems of energy transports in the atmosphere of a star in which, however, the heat conduction share is negligible.

It is evidently too complicated for our present discussions to outline the share of heat transfer at high temperatures in the glass bath; for this part of the calculations, a special publication of W. Geffcken[15] has given an accurate mathematical basis. In his deductions it is of high theoretical interest that he demonstrated how the cosinus factor in Lambert's law of surface radiation, which normally is imagined to be only an empirical factor, now appears as the mathematical consequence of an integral equation. The stationary surface radiation is then only a limit phenomenon of a more

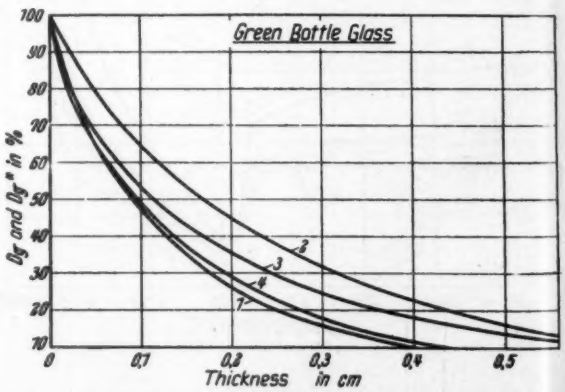


Fig. 11. Global Radiation Transmissivity of Green Bottle Glass (n = 1.53), as a Function of Thickness. (Czerny and Genzel).

(1) $$K_2^* = K_2(x) - \frac{n^2-1}{n^2} K_2\left(\frac{nx}{(n^2-1)^{1/2}}\right)$$

(2) The constant is mathematically defined by the equation

$$K_2(x) = \tfrac{1}{2}\,[x^2 \mathrm{Ei}(-x) + e^{-x}(x-1)],$$

and the exponential integral

$$\mathrm{Ei}(-x) = -\int_x^{\infty} e^{-t} t^{-1}\, dt$$

which is tabulated in Jahnke and Emde's book.[9]

Table 1. Global Transmissivity $D_{gl.}$ and $D^*_{gl.}$ for Window Glass (n=1.52).

Curve in Fig. 10	Transmissivity Type	Temperature of the Glass	Temperature of the Radiator	Approximation Equation
1	Dgl.	20°C.	1800°K.	$-[1.2K_2(0.4z)+0.8\ K_2(6.0z)]$
2	Dgl.	1300°C.	1800°K.	$-[1.4K_2(0.22z)+0.6\ K_2(2.0z)]$
3	Dgl.	1300°C.	1400°C.	$-[1.4K_2(0.25z)+0.6\ K_2(2.5z)]$
4	Dgl.*	20°C.	1800°K.	$[0.57e^{-43.z}+0.43e^{-4.6z}]$

Table 2. Global Transmissivity $D_{gl.}$ and $D^*_{gl.}$ for green Bottle Glass (n = 1.53).

Curve in Fig. 11	Transmissivity Type	Temperature of the Glass	Temperature of the Radiator	Approximation Equation
1	Dgl.	20°C.	1800°K.	$-2\ K_2\ (4.38z)$
2	Dgl.	1250°C.	1800°K.	$-2\ K_2\ (2.48z)$
3	Dgl.	1250°C.	1400°K.	$-[1.5K_2(2.3z)+0.5\ K_2(14.z)]$
4	Dgl.*	20°C.	1800°K.	$[0.77e^{-4.8z}+0.23e^{-30z}]$

generalized relation in which (for a low temperature gradient in the system) the radiation is coordinated to a "radiation conductivity" coefficient

$$\varkappa_s = \frac{16}{3} \cdot \frac{\sigma n^2 T^3}{k}$$

in which σ is Boltzmann's radiation constant. The analogy of this coefficient with the constant of pure heat conduction, $\varkappa_L$, is evident. Kellett gives the "radiation conductivity" in the same form, but with the factor 16/2 which accounts for having only considered the one-directional radiation flow, not the diffuse radiation problem. The "radiation conductivity" coefficient contains only the spectral absorption data of the glass, and radiation data of the blackbody. Geffcken demonstrated from the measurements given by Czerny, Neuroth and Genzel, that in the container glass investigated the chief contribution to the integral heat transport in the stationary heat flow equilibrium, called σ*, comes from the wave lengths between 1.3 and 2.4μ, in the window glass investigated from a range between 1.4 and 2.4μ, and for the X-ray protection lead glass from a range between 1.5 and 2.7μ. The increase of σ* with the temperature is surprisingly steep: from 1000° K. upwards, the data are about the same as for metals, e.g. iron and lead. At the same time, the absorption coefficient kλ are small, and the characteristic function

$$\sigma^* = \frac{4}{3}\pi n^2 \int_{\lambda_1}^{\lambda_2} \left(\frac{dE_\lambda}{dT}\right) \frac{d\lambda}{k_\lambda}$$

expresses the reciprocal relation of σ* to kλ. The whole calculation of σ*, however, can only have an explicit physical meaning if the layer of the glass is sufficiently thick for a total absorption of the entering radiation energy. Practically, this condition is fulfilled in "colorless" glass if the thicknes is at least 32 cm on both sides of the test plane (as the "critical" thickness). For a green glass, and the lead glass for X-ray protection, this condition is fulfilled, the critical thickness then being only 2 and 4 cm, respectively. For colorless glass, and especially for glasses which are very low in iron content, the calculation of σ* is restricted in its physical usefulness, although recent calculations have shown that a certain qualitative validity of σ* can be maintained, in this case also. The fact is important that even low concentrations in the Fe^{2+} cation decidedly affect the temperature distribution by diffuse radiation in a glass bath of a tank, or in a pot furnace, as was demonstrated immediately from Neuroth's results.

In spite of all, the explicit calculation of the radiation conductivity of a given glass at high temperatures is not an easy task, as soon as it is not treated as a "gray" absorber. This approximation, however, is not at all satisfactory, and the individual absorption curve in the visible and the infrared range should be introduced in principle. For the "gray absorber" glass the energy flow is represented by a function of the form

$$\Phi_{ss} = -\varkappa_s \cdot \frac{dT}{dz} \qquad \text{with} \qquad \varkappa_s = \frac{16}{3} \cdot \frac{\sigma n^2 T^3}{k}$$

(see above), which is a coefficient analogous to the usual heat conductivity, $\varkappa_L$. The spectral effects in a non-gray absorbing glass are highly complex, although accessible to approximating calculations, as Genzel[16] has demonstrated. It is assumed that the real absorption curve may be approximated by a series of steps (Fig. 12) of deliberately chosen wave length intervals. Instead of a very complex integration equation (with Taylor series developments which also Geffcken has used), more convenient step-wise integrations can be made from the experimental data for which tabulated mathematical functions[17] are available. Even Czerny's slide rule for radiation temperatures[18] may be used for the same pur-

(*Continued on page* 592)

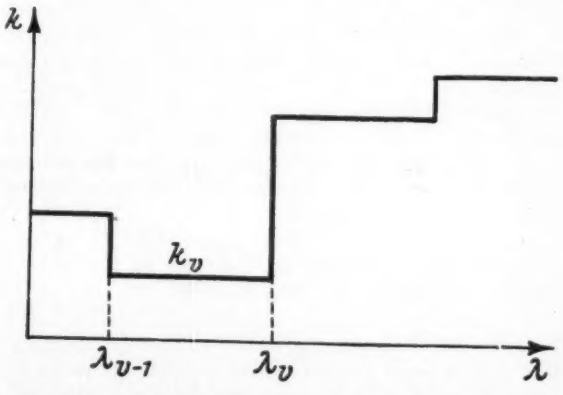


Fig. 12. Stepwise Absorption as a Function of Wave-Lengths, for Approximation of the Global Radiation Conductance in Glass. (Genzel).

Highest Attendance Marks Seventh Iron Clinic

Lowell Roesner opens seventh Iron Clinic.

• THE SEVENTH ANNUAL Iron Clinic was held on September 22nd in Winchester, Indiana and the Overmyer Mould Company, sponsor of this important one-day "convention," once again proved that as a supplier it continues to contribute greatly to the progress of glass through research and experimentation in glass molds metallurgy and manufacture.

One hundred and forty-five visitors including glassmen from six foreign countries met for the morning session of prepared talks and open discussion on varied problems of molds, mold metals and mold operations.

Following the welcoming address by Overmyer president, Lowell Roesner, the meeting was opened with the first showing of Omco's new color movie "The Birth of a Bottle" which was filmed at the company's Winchester mold plant and foundry. The film depicts how, in this case, a syrup bottle comes into being, from the drawing board to the pattern, the casting, the production of the completed mold and the mold in actual production in a glass plant.

While the scenes presented were commonplace to the assembled glassmen, the film was well received and it was felt that it could contribute greatly in promoting glass packaged products if shown in schools, women's clubs, service clubs, etc.

Following the film presentation, Earl R. Flatter, Overmyer's vice-president, took over as MC and moderator, during the question and answer period following each speaker's prepared talk.

The usual informal atmosphere, which has made the Clinic so highly successful in the past years, again prevailed at this seventh meeting and the response during the open discussion seemed to contribute substantially to the collective thinking of the entire group.

The first speaker of the morning was D. W. Morgan, representing the Imperial Oil and Grease Company, Los Angeles, California. Mr. Morgan in introducing his subject stated: "There is nothing new about metallic lubricants. We are not attempting to make metallic lubricants, as such, we do use certain elements of hydrocarbon petroleum to act as a vehicle or carrier to these solvents. The solvents do the work of lubrication required of petroleum products.

"I think, in order to make this subject just a little bit more understandable to you, the background of metallic solvents, as we have used them, would be in order. We use primarily molybdenum-di-sulfide as a principal agent for lubrication. We know molybdenum-di-sulfide to be an element mined, such as gold or silver, lead or copper. This element consists of two parts sulphur, one on either side, 'sandwich style if you please,' to one part of molybdenum. By taking the mine run material and reducing this product to less than 1/10th of a micron, we can suspend it or homogenize it into an oil vehicle or a suitable vehicle that can be dispensed to plate the surface of wearing areas or mating surfaces or various surface areas, so that all the wear that takes place occurs on the surface of these metal solvents.

"We use as high as eighteen finely divided solids to produce the end product. We know that there are only two requirements of any lubricant. The first is to keep metals apart and the second is to prevent galling or to reduce friction. If you reduce friction and keep metals apart your job is done. However, the replacement factor of these elements of lubrication that are required to maintain that condition is a factor that we accomplished.

"In other words, length of time on the surface of the material in actual surfacing is the one place that we are outstanding in our work."

Mr. Morgan then discussed the use of Molub-Alloy lubricant, which has been used by many industries with good success. The use thus far in the glass industry has been limited to certain areas; however, the success said to have been achieved, has indicated that the entire industry could benefit by using this type of lubricant in their high-speed glass operations. The lubricant reduces friction in any machine operation and has special heat resisting qualities. It also has a characteristic which provides a satisfactory reaction when sprayed on a hot mold during glass production. When the spray hits the hot mold, it immediately vaporizes, providing a carbon-free base in the mold cavity.

Following an interesting question and answer period

(*Continued on page* 602)

Standing left to right: H. A. Pyjnacker, Sr., H. A. Pyjnacker, Jr., United Glassware, Holland; sitting left to right: Torston Almquist, Sweden; Francois Frich, Souchon Nevesel, France; Jeoffery Lax, Lax & Shaw, England; D. C. Prodhan, Alembic Glass, India; Alfonso Sada, Fabricacion de Maquinas, Mexico.

Teaching and Research in Glass Technology In Great Britain

By Bernard P. Dudding, M.B.E.*

● THIS YEAR THE TEACHING and research work carried out in Great Britain, under the auspices of the Glass Delegacy of the University of Sheffield, is being divided between two organizations—the newly established British Glass Industry Research Association and the existing Department of Glass Technology of the University. Hitherto the Department, supervised by the Glass Delegacy—a body jointly representing the glass manufacturers and the University—has been responsible for teaching and fundamental research and for advisory and technical research work for the industry. The British Glass Industry Research Association, which came into existence at the end of last year, has taken over the technical research and advisory work, while the Department of Glass Technology will devote itself to teaching and academic or fundamental research work in the future. For the time being, the two organizations will share the same building, namely Elmfield, the beautiful and now internationally well known center of Glass Technology Department and of the Society of Glass Technology which stemmed originally from the work of the Department.

Dr. R. G. Newton has been appointed director of the new research association and Mr. R. W. Douglas, honorable secretary of Glass Technology and a colleague of the writer for twenty-eight years, succeeded, effective October 1st, Professor Moore as Professor and Head of the Department.

With the completion of this re-organization, the Glass Delegacy will cease to function. Its passing is a matter of regret to many; for it embodied a system of cooperation between an industry and a University of a unique and fruitful character. The passing of the Delegacy should not take place without paying a tribute to the ideals for which it has stood and to the initiative, leadership and work of Emeritus Professor W. E. S. Turner, from whose work other national and international organizations have derived their origin and stimulus.

The movement began at the outbreak of the First World War when Dr. Turner, then Lecturer in Physical Chemistry, made the suggestion to the University that it should set up a Scientific Advisory Committee to give technical advice on problems arising in industries operating in the University area. Turner consented to serve as Secretary. Among the problems presented were some from glass manufacturers. As none of his University colleagues could handle them, Dr. Turner made suggestions himself. The continuation of inquiries led him to ascertain the extent and character of the glass industry within thirty to forty miles of Sheffield. He found it extensive, and he believed, ready for a change in its attitude towards science. In a report presented to the University he recommended the creation of a new University Department to provide teaching and research in glass technology up to the highest levels. The University accepted the recommendation and created the Department in June 1915. Turner's personal desire was to continue his work in Physical Chemistry but he consented to organize the new department in addition.

In 1917 began the stream of papers which in the course of thirty years exceeded 500. Several of Turner's colleagues and helpers during the earliest years were his former chemistry students: English, Hodkin, Dimbleby and Parkin; Peddle and A. M. Jackson, although not members of the Department, assisted and had distinguished careers in the industry. The early teaching activities included not only courses leading to University degrees but also elementary courses conducted in many industrial centers in the country and specialized short courses during the summer months. There was also regularly issued from 1925 to 1945, at monthly intervals, the periodical "The Glass Review" summarizing recent published work and Glass Delegacy news. Able students from the Department and from other Universities were awarded scholarships or became Junior Members of the staff. Many of the leading technical executives in the British glass industry of the last generation have been students in the Department of Glass Technology.

A very important early development of the Department's work was the founding in 1916 of the Society of Glass Technology, which had its origin in some informal meetings and visits to works by adult students of local summer courses in 1916. The idea of a permanent Society was warmly received and in translating the idea into action, Turner had the wholeheated encouragement and help of Mr. Frank Wood, the head of several important glass works. Frank Wood was a man of great personal charm and, what was unusual in those days, a graduate in Science. He became first President of the Society, with Turner as Secretary, and a few years later became Chairman of the Glass Delegacy.

The formation of the Society had tremendous consequence in bringing together the glass makers of the United Kingdom. The Society organized visits to glass works, a thing previously unheard of, and manufacturers began to learn the value of cooperation. The extension of membership of the Society led to membership overseas and then in turn to overseas meetings. The first was a memorable meeting in the summer of 1920 in Pittsburgh of the Society of Glass Technology and the newly formed Glass Division of the American Ceramic Society under the Chairmanship of Dr. S. R. Scholas and the Secretaryship of Dr. E. W. Tillotson. This first international meeting was followed by others in France,

(*Continued on page* 600)

*President: International Commission on Glass.
Vice Chairman: Advisory Scientific Panel, Research Laboratories, The General Electric Co., Ltd., England

Inventions and Inventors

Feeding and Forming

Reinforced Forehearth Channel Joint. Fig. 1. Patent No. 2,707,353. Filed September 2, 1953. Issued May 3, 1955. One sheet of drawings. Assigned to Emhart Manufacturing Company by William T. Honiss.

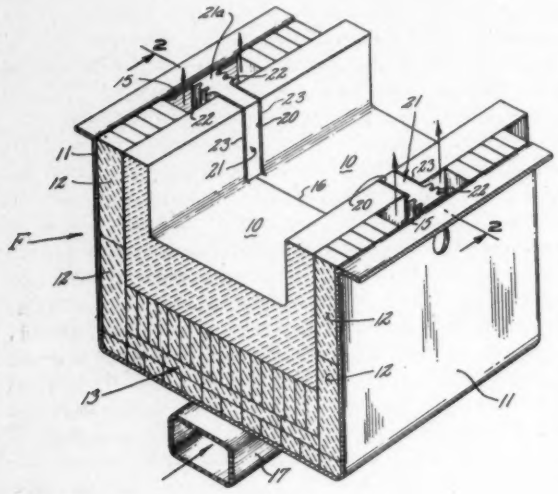


Fig. 1

The main object of the invention is to prolong the useful life of a forehearth channel which essentially comprises ordinary channel blocks, i.e. blocks made of bonded clay refractory material. According to the invention, bonded clay blocks 10, shown in Fig. 1, are cut away at their adjacent ends to the extent required to accommodate the inserts of electro-cast or fused refractory material to be placed in the joint between them. Inserts 21 of a fused or electro-cast refractory material that has a high heat conductivity and resistance to attack from molten glass, as for example, Monofrax tile, are set in these gaps. The inserts 21 may have projecting outer end portions 21a, extending across the cooling uptake side spaces 15 nearly to the adjacent portions of the metallic casing 11 and these projecting outer end portions of the inserts 21 may be formed with fluted or grooved side walls 22, to increase the area of contact of each with cooling air in its cooling passage. The amount of cooling air applied to the outer ends of the inserts can be regulated so as to maintian their inner ends, where they are in contact with molten glass, at a temperature below that at which such inserts will produce blisters in the glass and yet above a temperature at which undue chilling of the glass would take place. The temperature is believed to be in the order of 2400° F. and above. By the construction shown, the invention takes advantage of the high thermal conductivity of fused or electrocast refractory material while avoiding its gassing characteristic and the difficulty resulting from its uneven surface. Heat is abstracted rapidly from the bonded clay channel block surfaces exposed to glass attack at the channel joint and dissipated in the cooling air.

The patent contains six claims and the following references were cited: 811,223, Houze, Jan. 30, 1906; 1,328,380, Laird, Jan. 20, 1920; 2,174,458, Blau et al., Sept. 26, 1939; 2,582,477, Cannon, Jan. 15, 1952; and 996,009 France, Aug. 29, 1951.

Feeder Plunger Positioning Mechanism. Patent No. 2,707,354. Filed July 1, 1953. Issued May 3, 1955. One sheet of drawings (none reproduced). Assigned to Emhart Manufacturing Company by Karl E. Peiler.

The invention is an improvement over the adjusting mechanism for this purpose, that is included in a well known type of glass feeder, an example of which is disclosed in U. S. Patent No. 1,760,254. The object is to provide a positioning mechanism for the plunger of a feeder which is operable, to adjust the plunger horizontally along a line connecting the vertical center lines of two orifices in the bottom of the feeder glass discharge bowl or along a line parallel therewith or along a line perpendicular thereto, when the line connecting the vertical center lines of the two orifices intersects the plane of the feeder center line, at any acute or other desired angle or lies in such plane. It is desired to improve the plunger positioning mechanism of the feeder so that manipulation of but a single adjusting element will cause a horizontal adjusting movement of the feeder plunger in a direction having components of predetermined angular relationship to each other. The position may also be predetermined and charted for different angular locations of feeder shears.

The patent contains seven claims and the following references were cited: 1,760,254, Peiler, May 27, 1930; and 1,816,275, Algeo et al., July 28, 1931.

Sting-Out Baffle for Glass Feeder Rotor Bearing. Patent No. 2,707,355. Filed August 7, 1953. Issued May 3, 1955. One sheet of drawings (none reproduced). Assigned to Emhart Manufacturing Company by Karl E. Peiler.

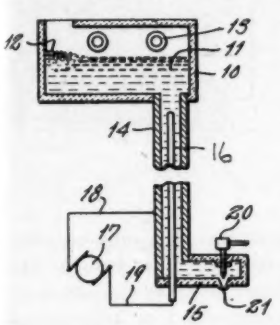
The upper end portion of the rotor of a glass feeder is held by an annular metallic carrier which is rotatably supported by bearing means a short distance above the portion of the spout cover that is provided, with the opening through which the feeder rotor depends. The metal ball bearings, or rollers of conventional mechanical bearings, may be "seized" because of the combination of high temperature and oxidizing action of the sting-out gases. In the present invention the sting-out gases are caused to pass substantially horizontally outward from the upper end of the sting-out passage between the feeder rotor and the spout cover opening, to an annular space between the spout cover and a flat annular baffle spaced a slight distance above and beneath the feeder rotor bearing. The sting-out gases will thus be diffused in the ambient atmosphere, without being permitted to move upward against the feeder rotor bearing and carrier.

Exposure of the feeder rotor bearing and adjacent parts to the sting-out gases and high temperature from the spout is prevented.

The patent contains three claims and the following references were cited: 2,093,212, Robertson, Sept. 14, 1937; 2,108,517, Wadsworth, Feb. 15, 1938; 2,305,739, Shackelford, Dec. 22, 1942; 2,474,615 Busquet, June 29, 1949, and 2,665,059, Newton, Jan. 5, 1954.

Furnaces

Glass Furnace and Method of Fining Glass. Fig. 2. Patent No. 2,707,717. Filed February 10, 1950. Issued May 3, 1955. Two sheets of drawings. John L. Seymour.



The great problem in glass making is to get a homogeneous product, but methods and furnace constructions have militated against the attainment of a perfect result. In Fig. 2 there is shown a furnace having a tube 10, which receives molten glass 11, either by pouring it in from some outside source or by melting it. From the bottom of the tank, at a place remote from the lump of raw materials, a carbon tube 14 extends downwardly. The tank 10 is shown as refractory and the tube 14 graphite. The tube is cylindrical as illustrated. The tube is connected at its bottom to a feeder 15, made of refractory as shown. Through the sole of the feeder a rod electrode 16, preferably graphite, extends axially into the tube, being adjustably mounted so that it may be extended into the tube 14 to different extents. An A. C. generator 17 supplies current to the tube and electrode by means of leads 18, 19 thus constituting them opposite poles of a Joule effect system. Thus, the tube and electrode constitute inner and outer, opposed, electrode walls, between which the glass flows in a stream of equal dimension at all opposed points. All parts of the glass may be subjected to fining by Joule effect for identical periods of time at identical intensity. The intensity may be varied by appropriate control of the current and both intensity and duration may be varied by inserting more or less of the electrode into the tube. The bubbles of fining make their way up through the tube 14 and burst on the surface of the raw glass in tank 10, the bubbles becoming fewer in the mid-length of the tube and being substantially absent from the glass at the feeder. The feeder is shown with valve 20 and discharge gate 21.

The patent contains fourteen claims and twenty references were cited.

Glass Compositions

Low-Reflecting Glass. Fig. 3. Patent No. 2,707,899. Filed August 28, 1951. Issued May 10, 1955. One sheet of drawings. Assigned to Radio Corporation of America by Frederick H. Nicoll.

This invention relates to a glass body having a composite two-layer surface film, the lower layer of which is a skeletonized film of silica and the upper layer of which is a substantially solid layer of silica. The treating solution is fluosilicic acid supersaturated with silica to the extent of about 0-3 millimoles of silica per liter of solution. A supersaturated solution of this type can be made up by diluting ordinary commercial 30 per cent fluosilicic acid to 1.4 molar and adding an excess amount of precipitated silicic acid or hydrated silica. Referring to Figure 3, a glass body 2, to be treated, is simply immersed in the solution and is permitted to remain until a skeletal layer of silica 4 is formed at a surface 6 of the glass. Treatment is continued until the surface film appears to be distinctly purple to reflected light. At this point, it will have minimum reflection for green light of about 5,000 A. and the skeletal surface film will have an optical thickness of about $\frac{1}{4}\lambda$. The next step in the process is to superimpose on the skeletal layer 4 a layer of substantially solid silica 12. This layer will ordinarily have an index of refraction of about 1.46. The solid silica layer may be deposited by immersing the article in a solution of fluosilicic acid supersaturated with silica to the extent of about 4-16 millimoles per liter of solution. During the initial part of the immersion period, deposited silica begins to fill in the voids near the surface of the layer of skeletal silica and reflection is increased. The reason for making the skeletal layer slightly more than $\frac{1}{4}\lambda$ in optical thickness is so that there will be an unfilled $\frac{1}{4}\lambda$ layer remaining after the filling in process. By optical thickness is meant the product obtained by multiplying the refractive index by real thickness. Maximum reflection is obtained when enough silica is deposited to produce a $\frac{1}{4}\lambda$ layer of deposited silica on top of the $\frac{1}{4}\lambda$ layer of skeletal silica. The multiple-type film thus formed possesses good non-reflecting properties and high resistance to atmospheric corrosion.

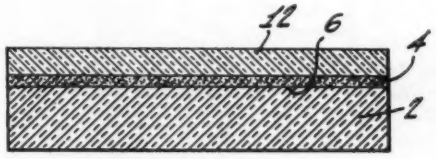


Fig. 3

The patent contains six claims and the following references were cited: 2,220,861, Blodgett, Nov. 5, 1940; 2,466,119, Moulton et al., Apr. 5, 1949; 2,474,061 Moulton, June 21, 1949; 2,486,431, Nicoll et al., Nov. 1, 1949; 2,490,662, Thomsen, Dec. 6, 1949; 2,505,629, Thomsen et al., Apr. 25, 1950; and 2,531,945, Moulton, Nov. 28, 1950.

Glass Wool and Fiber

Method of and Apparatus for Producing Glass Fibers. Fig. 4. Patent No. 2,708,813. Filed May 31, 1949. Issued May 24, 1955. Three sheets of drawings. Assigned to Societe Anonyme des Manufactures des Glaces & Produits Chimiques de Saint-Gobain by Maurice M. Bourgeaux.

The invention relates to a curled or crimped or undulated glass fiber and to an apparatus and process for producing the same. The filament 1, Fig. 4, may be formed by being drawn downwardly from glass issuing in a cone from one of a series of spinnerettes, fed with

molten glass, by means of a drum 3. The fiber is passed adjacent to a wetted or filmed surface and in contact with the liquid film. This film 5 may be caused by permitting a cooling liquid to issue through a porous body or diaphragm 8, forming the upper portion of the front wall of a trough 4, containing a suitable liquid such as water, and the pressure within which is regulated by a controllable escape pipe 17. Below the trough is a tray 9 to receive the liquid flowing down from the front face of the trough. The trough is pivoted at 14, in a frame 11, vertically adjustable in respect ot the spinnerettes by screws 10 and may be moved laterally, in respect to the vertical plane containing the spinnerettes by the screw 12, bearing against the arm 13 fastened to the trough. With the trough properly adjusted, the fibers will be wetted on one side. One side will, therefore, be chilled in respect to the other side and be thereby tempered and will contract axially producing a fiber which will tend to curl when set. The curled or crimped fibers have obvious advantages and can be used as a reinforcing material of numerous products, especially of a fibrous type, such as paper, their shape permitting a better intermixing of the fibers with the material to be reinforced. In the case of cement or other materials having no special affinity for glass fibers their particular shape insures a better adherence of the material to the glass fibers.

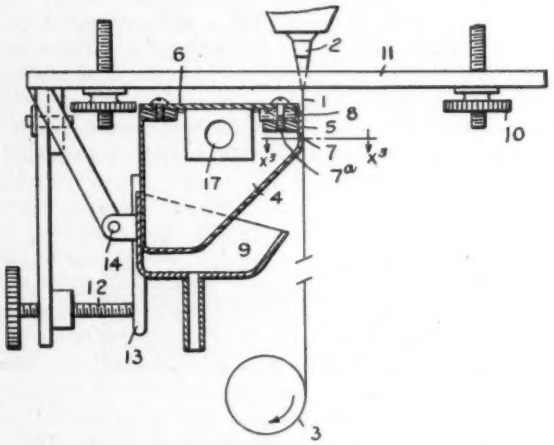


Fig. 4

The patent contains seventeen claims and twelve references were cited.

Means for Treating Mineral Wool Fibers. Fig. 5. Patent No. 2,707,847. Filed May 24, 1952. Issued May 10, 1955. One sheet of drawings. Assigned to American Rock Wool Corp. by Carl A. Anliker.

The present invention relates to the treatment of mineral wool fibers formed from molten slag or suitable mineral material and more particularly to a novel means and manner of applying to such resulting fibers an annealing oil, waterproofing composition or binder, to assure uniformity in the application of the treating or coating composition to such fibers as they leave the fiberizing unit. To most effectively treat these fibers a novel applicator unit 24, shown in Fig. 5, projects into

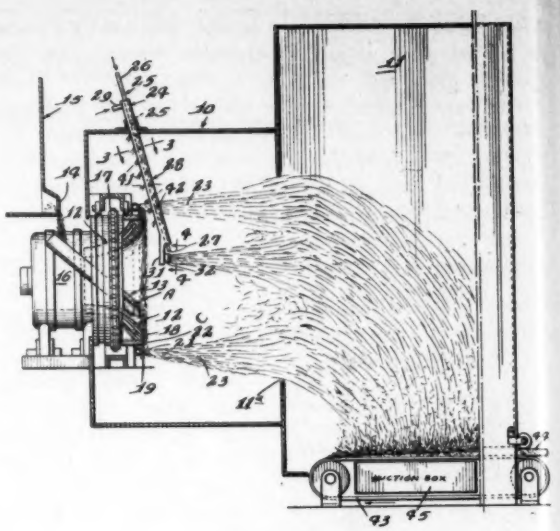


Fig. 5

the collecting hood 10. It comprises a tube or conduit 25, having an inlet at its upper or outer end 26 and a discharge outlet 27, at its inner or lower end for supplying the desired treating composition or solution. Encompassing this tube or conduit 25 is a substantially larger tube, pipe or conduit 28 having an inlet 29 at or adjacent its upper or outer end and an offset 31 at its lower or inner end provided with a lateral discharge nozzle 32. This discharge nozzle is disposed closely adjacent to the discharge outlet 27 of the tube or conduit 25 carrying the treating solution. The discharge nozzle 32 is disposed beneath the open lower discharge end 27 of the tube for atomizing the treating solution as it leaves the open end of this tube. Connected to the inlet 29 is a supply of steam, air, gas or other suitable fluid under pressure adapted to issue from the slots or notches 33 (not shown). To maintain the external surface of the encompassing tube, pipe or conduit 28 free of collected wool fibers, it is provided with a plurality of longitudinally and laterally spaced orifices for the discharge of the steam or other medium supplied to this conduit. By this novel arrangement, the liquid treating substance is atomized in approximately the center of the annular wool stream as the formed fibers leave the fiberization unit and is distributed uniformly on these fibers as they pass through the collector hood or collection chamber 11.

The patent contains seven claims and fifteen references were cited.

Miscellaneous Processes

Method of Welding Aluminum to Glass. Patent No. 2,707,850. Filed April 5, 1951. Issued May 10, 1955. One sheet of drawings (none reproduced). Assigned to Corning Glass Works by Robert H. Dalton and Raymond O. Voss.

This invention relates to glass-to-metal seals and is particularly concerned with the sealing or welding of glass to aluminum. An aluminum structural member can be successfully sealed or welded without melting, to a glass having a working point above the melting point of aluminum by the use of a sealing glass having a working

point below the melting point of aluminum and a thermal expansion coefficient not more than 10 x 10^{-7} per ° C. different than that of the first glass, provided that the thickness of the aluminum member at the area of sealing or welding is not over 7 mils. Glasses which are particularly suitable comprise essentially 60 per cent to 85 per cent PbO, 5 per cent to 15 per cent Al_2O_3 and at least one glass-forming oxide in the indicated proportion selected from the group consisting of up to 40 per cent B_2O_3 and up to 20 per cent SiO_2, the sum of such essential oxides being over 80 per cent. An especially desirable composition within this range consists approximately of 75 per cent PbO, 11 per cent Al_2O_3, 11 per cent B_2O_3 and 3 per cent SiO_2, which has a working point of about 560° C. and an expansion coefficient of 84 x 10^{-7} per °C. The working point of the sealing glass must be below the melting point of aluminum so that it can be heated sufficiently to weld with the aluminum and with the higher working glass without melting the aluminum.

The patent contains eight claims and twelve references were cited.

Method of Coating Glass Bulbs. Patent No. 2,706,691. Filed May 10, 1950. Issued April 19, 1955. One sheet of drawings (none reproduced). Assigned to Osram G. m. b. H. Kommanditgesellschaft by Franz Schafer.

The invention relates to a method of depositing a coating of fine powder on the glass walls of electric lamps wherein the glass wall is coated with a suspension containing the fine powder and after pouring off the excess suspension, the remaining film is dried. A suitable suspension comprises 22 grams of magnesium fluoride and 11 grams of calcium fluoride to 1,100 cc. of water as the inorganic materials that produce the gel, and also 66 grams of silicic acid (or silica) as light-diffusing material, as well as 10 cc. of phosphoric acid as adhesion means. This suspension is poured into the glass bulb and the latter, after the excess suspension has been drained off, is then dried and baked in an oven at a temperature of about 400° C. Such coatings have such a favorable effect upon the (voltage) breakdown strength of the incandescent lamp that a filling of argon with less than 10 per cent, or even less than 5 per cent nitrogen can be used, which is known to make possible a higher light output of the incandescent lamp. In some cases it is advisable to add to the colloidal solution, or the gel, certain materials such as, for example, alcohol, boric acid, phosphoric acid or alkaline salts, which will maintain the required viscosity of the suspension for a longer time or will assist in the development of a thick, uniform, well-adhering coating.

The patent contains five claims and ten references were cited.

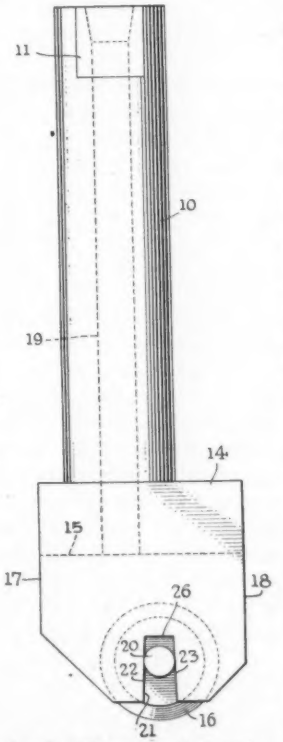
Sheet and Plate Glass

Glass Grinding. Patent No. 2,706,876. Filed June 28, 1954. Issued April 26, 1955. One sheet of drawings (none reproduced). Assigned to Libbey-Owens-Ford Glass Company by William C. Levengood.

A method is presented for eliminating edge fractures and scratches in glass, particularly in sheet glass. In attempting to find the cause of weak edge areas, it was found that surfaces of ground and polished plate glass sometimes contain scratches or streaks commonly referred to as "block reek." Such scratches and streaks have been shown to be a composite of minute intermittent rubs and scratches and are believed to be caused by chips of glass embedded in the polishing felts which scratch or abrade the glass sheets during polishing. These chips are believed to originate along the edge portions of the sheets when they are polished, and to be caused by thermal shock created when the rouge water polishing solution, at a temperature of approximately 80° F., strikes the glass being polished with a surface temperature of well over 200° F. To alleviate this condition, it was found that such edge chipping could be reduced considerably by altering the surface structure of the edge in such a manner as to prevent or reduce the formation of the microscopic fissures that extend into the body of the glass and act as origins for fractures. The altering of the surface structure of the edges of a glass article may be brought about by seaming or grinding the edges, using a 5% water solution of cupric chloride ($CuCl_2 2H_2O$).

The patent contains five claims and no references were cited.

Improved Glass Cutting Machine. Fig. 6. Patent No. 2,707,849. Filed January 8, 1953. Issued May 10, 1955. One sheet of drawings. Assigned to Pittsburgh Plate Glass Company by Guy C. De Vore.



It is the object of this invention to provide a pillow post type of holder for a glass cutting wheel and axle which does not require the use of spring clips, detents, latches, deformed axles, resilient materials, or the like. The cutting wheel 16, shown in Fig. 6, is rotatably mounted on an axle 20 which projects from each side of the wheel. The projecting portions of the axle 20 are received in a slot 21 cut in the head 14 at right angles to the slot 15. The slot 21 is cut to accurate size to receive and hold the axle 20 therein, without the use of retaining clips, springs, or latches. It is found that providing slot 21 with a slight taper on the opposing walls 22 and 23 results in firm frictional contact with the portions of axle 20 engaged thereby, and that by this means a glass cutting wheel may be easily mounted in a pillow post and may be easily removed from the post for repair or replacement. The slope of the sides 22 and 23 provides a wedging action which firmly grips the wheel axle 20 to secure the wheel 16 in the post head 14 without other fastening means. The axle 20 may be easily removed from

the slot 21 by inserting a pointed implement, such as a nail, in the slot 21 between the axle 20 and the end 26 of the slot 21 to pry the axle 20 downward. It is understood that the axle 20 is held in the tapered portion of slot 21 by a wedging action rather than by any inherent resilience of the material of the head 14.

The patent contains four claims and the following references were cited: 1,634,323, Fletcher, July 15, 1927; 2,096,284, Lee, Oct. 19, 1937; and 2,312,635, Fletcher, Mar. 2, 1943.

Visual Inspection Device for Curved Glass Sheets. Fig. 7. Patent No. 2,708,857. Filed February 10, 1951. Issued May 24, 1955. Two sheets of drawings. Assigned to Libbey-Owens-Ford Glass Company by K. E. Golding.

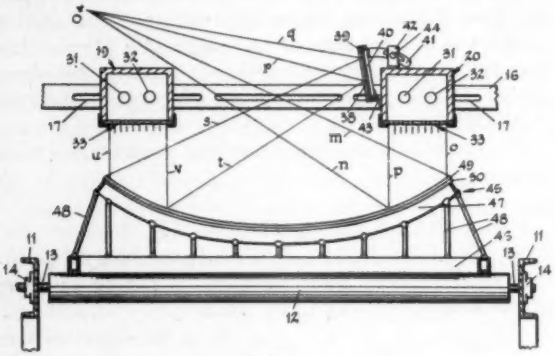


Fig. 7

The present invention relates broadly to the bending of sheets or plates of glass and more particularly to a novel and improved means by which the non-conformity in curvature of glass sheets bent in pairs may be readily and effectively detected by visual inspection. Referring particularly to Fig. 7, it will be seen that as a plurality of parallel lines of light strike the bent glass sheets 49 and 50, the lines will be reflected from the upper and lower surfaces of each of the sheets 49 and 50. The number of reflections of each of the parallel lines will depend upon whether the glass sheets are properly "nested," that is, whether there is an absence of void spaces or spaced areas between. When the observer O views the bent glass sheets 49 and 50 he will see a triple reflection of the parallel lines of light from the surfaces of the sheets when there is proper nesting thereof, and will see a quadruple reflection when improper nesting exists. The reflected lines of light from the lower surface of the sheet 49 and upper surface of the sheet 50 will be superimposed due to the intimate contact therebetween when there is proper nesting, while the reflected lines from the surfaces are separate when improper nesting is present.

The patent contains seven claims and the following references were cited: 1,590,532, Lenouvel, June 29, 1926; 1,837,979, Mensman, Dec. 22, 1931; 2,015,730, Rosin et al., Oct. 1, 1935; 2,239,263, Waine et al., Apr. 22, 1941; 2,247,047, Bishop, June 24, 1941; and 2,291,152, Carter, July 28, 1942.

Tube and Cane Machines

Manufacture of Cup Type Glass-to-Metal Seals. Fig. 8. Patent No. 2,709,872. Filed October 4, 1951. Issued June 7, 1955. Two sheets of drawings. Assigned to General Electric Company by Stanley L. Slomski.

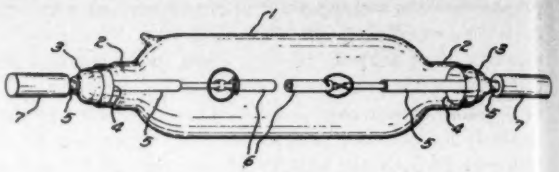


Fig. 8

The present invention relates to electrically conducting seals of the cup seal type and its principal object is to provide an economical mass production method of and a simple means for hermetically uniting the glass and the rim of the metal cup. Referring to Fig. 8 of the drawings, the lamp illustrated comprises a double-ended tubular glass envelope 1, having a necked portion 2 at each end closed by a metal cup 3 having its rim 4 shaped to a feathered edge and hermetically united with the glass neck portion 2. A rod-like metal conductor 5 is brazed gas-tight to and extends through the bottom of each cup 3 and supports an electrode member 6. The electrode members 6 are spaced apart to provide a discharge path in the center portion of the envelope 1. The external ends of the conductors 5 are of large diameter and are in the form of a post 7 for connection to the terminals of a power source for the lamp. The cups 3 are hermetically united to the glass envelope 1. This method is useful for seals including an iron-nickel-cobalt alloy sold under the trade-mark "Fernico" and with borosilicate hard glass of the type known in the trade as suitable for sealing with "Fernico."

The patent contains five claims and eleven references were cited.

Apparatus for Attaching Glass Elements to Metal Parts. Patent No. 2,707,848. Filed November 27, 1950. Issued May 10, 1955. Four sheets of drawings (none reproduced). Albert F. Pityo.

Apparatus is provided whereby glass rods may be anchored to metal pins secured to gun components of cathode ray tubes. A plurality of metallic tubes having radial pins secured thereto are positioned within a holder, and the metallic tubes adjusted and held in place within the holder to provide longitudinal sets of radial pins, with the pins in each set in alignment and the sets of pins equidistantly circumferentially spaced. A glass rod is heated and plasticised at selected points and applied to one longitudinal set of pins at the first station and the pins become embedded in the plasticised portion. The holder is turned upon its longitudinal axis when being indexed to the next station for 120 degrees and this brings the next longitudinal set of pins into position to have a similar heated glass rod applied to this longitudinal set of pins. The holder is again turned to bring the remaining longitudinal set of pins into position to have the heated glass rod anchored to such pins. The indexing of the holder continues until the loading station is reached, at which time the glass rods have suitably cooled and hardened and the finished product removed from the holder and the holder again loaded with the metallic tubes.

The patent contains 24 claims and 13 references were cited.

Research Digest

Effect of Na_2O/K_2O Ratio on Chemical Durability of Alkali—Lime—Silica Glasses

As a result of Peddle's work (1920) on the durability of mixed-alkali glasses, it has been generally accepted that some glasses containing both soda and potash are more durable than glasses containing soda or potash as the only alkali. Having developed direct methods of determining the individual ions, Sen and Tooley considered it worth while to repeat a study of this general type by measuring the actual ion concentrations, rather than using Peddle's indirect method of titrating the total alkalinity by sulfuric acid. Also, Peddle's method of sample preparation was not conducive to control of surface area exposed, owing to the small particle sizes used. Each sample of glass was powdered and passed through a 160-mesh sieve. This method gave particles 0.009 cm. in diameter and smaller, hence control of particle-size distribution was difficult.

Peddle's work indicated that the maximum resistance in four different varieties of lead glasses occurred at approximately the same K_2O/Na_2O (by weight) ratio, namely 2.33.

Another object of the present work was to develop some preliminary ideas on structural grounds as to why certain ratios of Na_2O and K_2O in a glass are preferable to others from the standpoint of durability.

The results of these studies are reported in the May 1955 issue of the Journal of the American Ceramic Society by Messrs. Sen and Tooley.

The compositions of the glasses employed in this work are given in Table I. The procedure adopted for the preparation and exposure of the samples for the durability tests was the same as The American Ceramic Society tentative method No. 1. The resulting solutions were used to determine sodium, potassium, calcium and silica and the results were expressed directly as their concentrations in these solutions. Sodium and potassium were determined by the Perkin Elmer flame photometer using lithium chloride as the internal standard. In the case of calcium, the turbidity developed by Duponol-oleate reagent was measured with a photolometer and compared with a standard series. The modified silicomolybdate method was used for silica. It is based on the development of blue color by the reduction of silicomolybdate yellow (obtained by the reaction of silica and ammonium molybdate) with sodium sulfite. The results obtained are given in Table II and in the original paper were also expressed graphically.

The curve for alkali extracted (expressed as Na_2O and K_2O) as a function of the alkali content of the glass shows a minimum at about 5 per cent Na_2O and 13 per cent K_2O in the glass, a ratio of 2.6:1 as compared with the ratio of 2.33:1 indicated by Peddle for lead glasses.

Low extraction values for calcium compared with sodium and potassium are noted from an examination of Table II. This result is not surprising and reflects the classical interpretation of calcium as a stabilizing influence when alkali-lime-silica glasses are attacked by water.

Consideration of the results from a structural standpoint is facilitated if the data are plotted on an ionic basis such as the number of gram ions of alkali per 100 grams of material as a function of alkali content in the glasses. A comparison of such plots indicates clearly that a major factor controlling the relative amounts of Na^+ and K^+ removed from the glasses is simply their relative concentrations in the original glass.

Another interesting point, much more revealing from the structural standpoint, is disclosed when the "excess" alkali ions in the extract are plotted against the total alkali in the glass. In these plots the ordinate unit (number of "excess" alkali ions in the extract) is designated N and has the following meaning:

$$N = \frac{\text{Number of cations in extract}}{\text{Number } Si^{4+} \text{ in extract}} - \frac{\text{Number } Si^{4+} \text{ in glass}}{\text{Number } Si^{4+} \text{ in glass}}$$

"Cations" in the foregoing expression refers to the different modifying cations in the system: Na^+, K^+, and Ca^{++}. Thus the N values, which may be designated N_{Na^+}, N_{K^+}, and $N_{Ca^{++}}$ are calculated from the composition date for each glass and extract pair. It is suggested that the value N may be used as an empirical index of the amount of ion-exchange reaction, unaccompanied by network breakdown, that occurs under a given set of exposure conditions. Thus, if ions appear in the extract in the same relative concentration in which they existed in the original glass, the type of attach involves network breakdown, even though this mechanism most probably is preceded by ion-exchange reactions. On the other hand, if an alkali is extracted from the glass in amounts exceeding the ratio it bears to Si^{4+} in the original glass, it may be concluded that such an alkali is removed by the

(*Continued on page* 594)

TABLE I
Composition of Glasses (%)

Glass No.	Na_2O	K_2O	CaO	SiO_2
GX1	0	18	10	72
GX2	3	15	10	72
GX3	6	12	10	72
GX4	9	9	10	72
GX5	12	6	10	72
GX6	15	3	10	72
GX7	18	0	10	72

TABLE II
Soluble Material in Extracts (Parts per Million)

Glass No.	Na_2O	K_2O	CaO	SiO_2
GX1	0	54	4.0	3.4
GX2	9	35	2.6	3.4
GX3	18	25	4.0	6.0
GX4	31	20	5.0	6.4
GX5	51	16	6.2	7.4
GX6	91	13	7.5	8.1
GX7	170	0	8.0	8.7

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during August, 1955 was as follows: *Flat Glass:* A preliminary figure of 28,900 for August 1955 indicates a rise of only .4 per cent from the adjusted 28,800 reporetd for July 1955. *Glass and Glassware, Pressed and Blown:* An increase of 4.1 per cent is shown by the preliminary 78,800 figure of August 1955 when compared with 75,700 of July 1955. *Glass Products Made of Purchased Glass:* The preliminary 14,700 of August 1955 indicates a rise of only 5.8 per cent from the previous month's 13,900.

Payrolls in the glass industry during August 1955 were as follows: *Flat Glass:* A decrease of .5 per cent is shown in the preliminary $13,790,791 when compared with July adjusted $13,865,184. *Glass and Glassware, Pressed and Blown:* An increase of 3.8 per cent is shown in the preliminary $25,159,264 reported for August 1955 when compared with the previous month's adjusted $24,245,196. *Glass Products Made of Purchased Glass:* A preliminary figure of $4,270,497 was reported for August 1955. This is 12.5 per cent higher than the adjusted July figure of $3,798,314.

GLASS CONTAINER SHIPMENTS
(All Figures in Gross)

	September 1955
Narrow Neck Containers	
Foods	1,750,000
Medicinal & Health Supplies	1,221,000
Chemicals, Household & Industrial	865,000
Beverages, Returnable	384,000
Beverages, Non-returnable	96,000
Beer, Returnable	102,000
Beer, Non-returnable	637,000
Liquors	832,000
Wines	381,000
Toiletries & Cosmetics	945,000
Sub-total (Narrow)	7,213,000
Wide Mouth Containers	
Foods	*2,871,000
Dairy Products	329,000
Medicinal & Health Supplies	381,000
Chemicals, Household & Industrial	153,000
Toiletries & Cosmetics	115,000
Packers' Tumblers	132,000
Sub-total (Wide)	3,981,000
Total Domestic	11,194,000
Export Shipments	227,000
TOTAL SHIPMENTS	11,421,000

*This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY
(All Figures in Gross)

		Production Sept. 1955	Stocks Sept. 1955
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck..	7,324,000	8,258,000
	Wide Mouth.	*4,215,000	*4,782,000
Dairy Products		299,000	290,000
Beverages, Returnable		412,000	1,149,000
Beverages, Non-returnable		84,000	234,000
Beer, Returnable		133,000	315,000
Beer, Non-returnable		622,000	610,000
Liquors		922,000	1,125,000
Wines		370,000	442,000
Packers' Tumblers		147,000	172,000
		11,539,000	13,040,000

*This figure includes Fruit Jar and Jelly Glasses.

Glass container production, based on figures released by the Bureau of Census, dropped 12 per cent during September 1955 to reach 11,539,000 gross. This is a decrease from the previous month's 13,109,000 gross. During September 1954, production was 9,883,000 gross, or 16.6 per cent below September this year. Glass container production at the end of the first nine months of 1955 has reached a total of 103,365,000 gross, which is 7 per cent ahead of the 96,071,616 gross produced during the same period in 1954.

Shipments of glass containers during September 1955 dropped 21.8 per cent to reach 11,421,000 gross. This is a decrease over August 1955 shipments which were 14,604,000 gross. Shipments during September 1954 were 10,853,000 gross, or 5 per cent below September 1955. At the end of the first nine months of 1955, glass container manufacturers have shipped a total of 102,098,000 gross, which is 8.7 per cent ahead of the 93,251,195 gross shipped during the corresponding period last year.

Stocks on hand at the end of September 1955 were 13,040,000 gross. This is only slightly below August 1955 stocks of 13,263,000 gross and 0.3 per cent lower than the 13,299,000 gross on hand at the end of 1954.

Automatic tumbler production during August 1955 was 5,931,118 dozens. This is an increase of 20.3 per cent from July production which was 4,916,468 dozens. Production during August 1954 was 5,131,368 dozens. Shipments during August 1955 rose to reach 5,626,837 dozens. This is 23 per cent higher than July 4,568,209 dozens. During August 1954, shipments were 5,219,869 dozens. At the end of the 12-month period ending August 1955, shipments have reached a total of 61,994,943 dozens, which is 1.9 per cent higher than the 60,837,100 dozens shipped last year.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware during August 1955 rose 44.2 per cent to reach 3,421,346 dozens. This is an increase from July 2,371,834 dozens. During August 1954, sales were 2,965,741 dozens. At the end of the 12-month period ending August 1955, manufacturers had sold a total of 37,932,275 dozens, which is only slightly below the 37,184,498 dozens solds during the same 1954 period.

● A new color and sound motion picture entitled, "Everything Under Control" has been released by the Pemco Corporation, Baltimore, Maryland. The film shows how various ceramic coating materials are made and how they help sell appliances, dinnerware and glass packaged products.

New Equipment and Supplies

GRATE MAGNET

The Eriez Manufacturing Company, Erie, Pa., has designed the Model P Grate Magnet (shown above), particularly for installation in odd shaped, round, oval or round cornered hoppers. The grid bars are positioned over the magnetic element, acting as baffles to deflect the flow of material onto the permanent magnetic tubes where any tramp metal is trapped and held.

NEW STATIC PRESSURE CONTROL

The Henry G. Dietz Company, 12-16 Astoria Boulevard, Long Island City 2, New York has added the Cat. 114P Sensitive Static Pressure Control to its line of low pressure switches.

The Cat. 114P Control is approved and listed by both Factory Mutual and Underwriters Laboratories, Inc. for use as an air fuel interlock switch in packaged steam generators requiring safeguards to prevent flow of fuel when a hazardous condition is present due to lack of forced draft. The contacts of the switch are usually wired in series with the solenoid of the oil shut off valve. Thus, the oil valve will prevent flow of fuel unless the blowers are supplying the proper amount of forced draft.

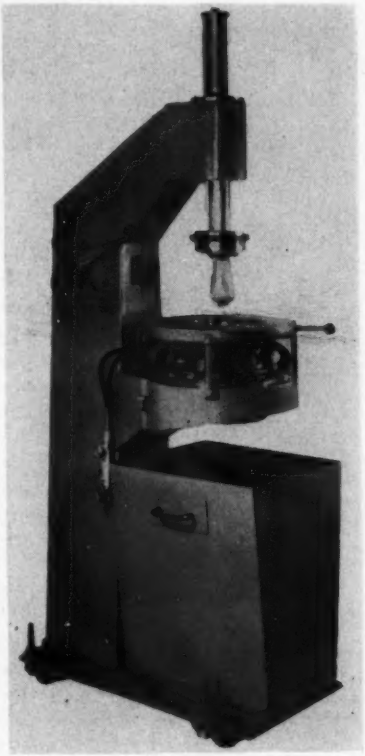
MINIATURE RECORDING POTENTIOMETER

Westronics, Inc., 3605 McCart Street, Fort Worth, Texas, have announced that the Westronics Miniature Strip Chart Recording Potentiometer, weighing less than 25 pounds, is now available with standard charts and ranges for copper constantan, iron constantan and chromel alumel thermocouples and has internal cold junction compensation.

This recorder, of the null balance potentiometer type, records on a 5 inch strip chart, with a pen speed of one second full scale and an accuracy of better than 0.5 per cent. Standardization is continuous and automatic; no standard cell or batteries are used. A variety of chart speeds are available, with 3-speed chart drive optional. Auxiliary control features are available.

NEW TYPE GLASS BURN-OFF MACHINE

Standard Automation Products, a division of General Industries of America, 1738 Ridgeway Road, Havertown, Pennsylvania, has introduced an automatic glass burn-off machine which has important advantages over equipment that is in standard use for glass burn-off work.



Using the principle of rotating multiple gas jets, this new machine produces a finished product that is stress-free. It is well known that when the blow-over of glass is cracked off by conventional methods, the glass has been cooled before the cracking off takes place so that stresses are formed in the glass during the re-heating. This causes the glass to splinter near the edge where the cracking off has taken place. The manufacturer of this machine claims that this disadvantage is avoided by using his machine, as the glass is not cooled in the annealing lehr until the whole job has been completed. There is, therefore, a great improvement in both the stress-free qualities as well as the uniformity of the finished product.

CATALOGS RECEIVED

The Chas. Taylor Sons Co., a Subsidiary of National Lead Company, 710 Burns Street, Cincinnati, Ohio, has published a new bulletin, No. 318, which describes its *Tamul*, *Tasil* and *Tamax* brands of refractories. This is an 8-page illustrated bulletin which discusses the properties and applications of these sillimanite-type or bonded mullite special high temperature refractories.

American Potash & Chemical Corporation, 3030 West Sixth Street, Los Angeles 54, California, have prepared an informational folder on Trona soda ash. Included in the pamphlet is information regarding production, various grades of soda ash, distribution and other material pertaining to industrial applications.

Kaiser Chemicals Division, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California, have published a new Identification Guide to Kaiser Refractory Brick and Furnace Grains.

This is a well presented, attractive folder designed to aid in quick and accurate identification of the different types of brick, Permanente mixes, mortars and grains.

The Minneapolis-Honeywell Regulator Company, Industrial Division, Wayne and Windrim Avenues, Philadelphia 44, Pennsylvania, has issued Bulletin 100-D, an Index of Industrial Division Literature. The index is broken down by subject, industry, product. It covers catelogs, bulletins, specification sheets, data sheets and articles from Instrumentation Magazine.

The company's bulletin 9320 describes a new high speed radiation detector which responds to 98 per cent of any temperature change in less than one-half second. Applications, features and specifications are given.

Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia 44, Pennsylvania, have just issued their index to L & N Publications which may be of service when requiring information about automatic controls or measuring instruments, or various manufacturing processes in industry. They also maintain a substantial supply of photographs of processes in heat-treating, scientific research, chemical processing, etc.

Bethlehem Apparatus Company, Inc., Hellertown, Pennsylvania, have issued Catalog No. 54. This catalog contains a section on glassworking equipment such as lab-lathe and accessories, burners, cut-off (wet-Cut) machine, technical article seal-crib for storing glass tubing, etc.

Thermal Transmissivity . . .

(*Continued from page* 581)

pose. This process of calculation has a full physical meaning and is demonstrated by Genzel in curves for the radiation conductivity of glasses, from Neuroth's measurements (Fig. 13). In this graph is particularly interesting the comparison of the curves for $\varkappa_s$ as a function of temperature with those for $\varkappa_L$, the average true heat conductivity. The much larger share of radiation conductivity at high temperatures for the heat transfer phenomenon is most evident from the graph, and this result is also in agreement with the theoretical discussions of B. S. Kellett[13].

The admirable theoretical work done by the authors mentioned above is highly interesting because of many possibilities of comparison with previous results of British and American authors who have studied the distribution of temperature in glass baths. First, G. V. McCauley[19] has discussed the share of convection, thermal conductivity, and radiation in the heat flow phenomena in liquid glass with remarkable erudition. He derived a "complex conductivity" of glass which includes both conductivity effects, and emphasized the very steep increase of this complex with increasing temperature which distinguishes it from ordinary heat conduction. Further, R. Halle, E. Preston, and W. E. S. Turner[20] attacked especially the problems of the effects of coloring constituents in glass by heat absorption on the temperature distribution in the bath, and the practical phenomena of the temperature gradients in the large masses of molten glass of a tank furnace. J. Boow and W. E. S. Turner[21] extended these methods to the experimental study of the heat distribution in the glass on its way of

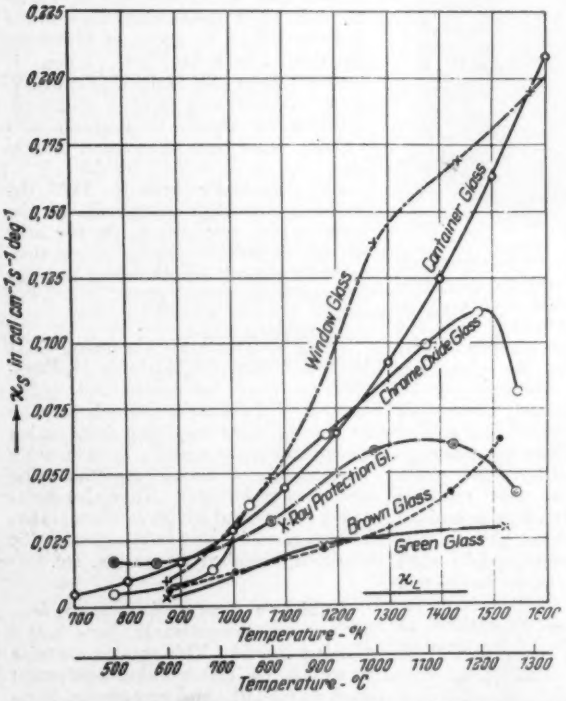


Fig. 13. Radiation Conductance, κ_s, of Several Glasses, as a Function of Temperature. For Comparison, the Average True Heat Conductance, κ_L, is Plotted. (Genzel).

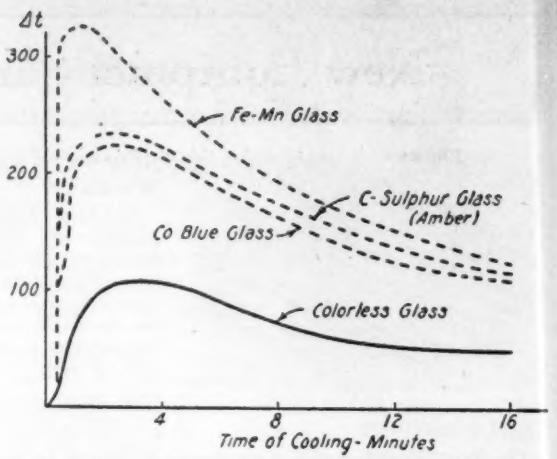
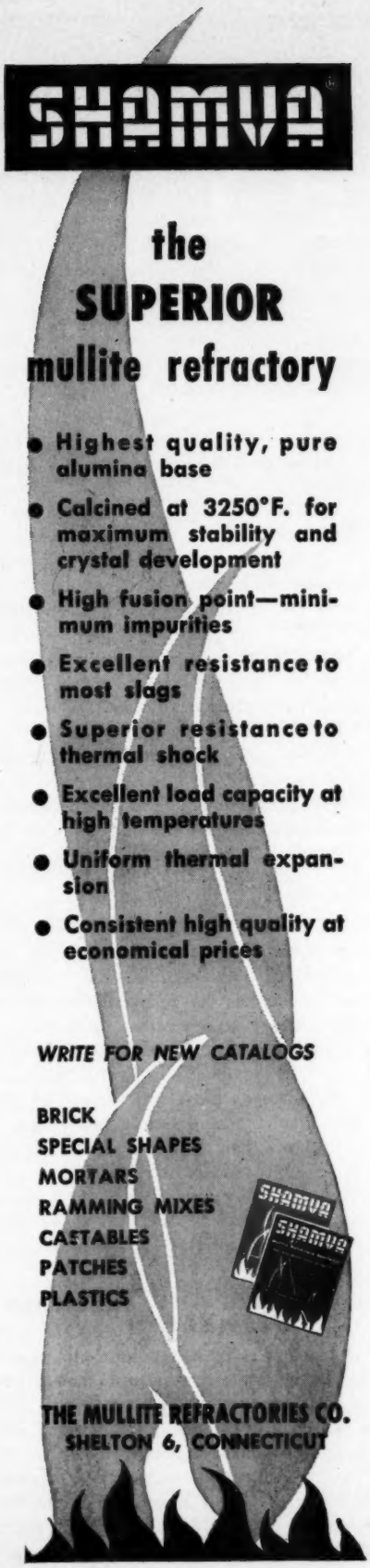


Fig. 14. Effects of Infrared Absorption in Glass Melts. Temperature Difference Between the Surface of the Glass Melt and 0.8 inches Deeper (after J. Boow and W. E. S. Turner) (Courtesy of the Society of Glass Technology).

viscous flow through the furnace, and in the working process, either by manipulation by hand in the blowpipe, or by automatic machines including the wall effects (cooling) of the moulds. In every case, the surface temperature determined by thermocouples and optical pyrometers, and the temperatures in the inner parts of the glass melt were strongly dependent on the content of the glass in oxides which affect the radiation conductivity, especially if FeO,CoO,MnO, etc., are concerned. These highly meritorious investigations have given, for the first time, accurate orientation data on the temperature and viscosity conditions of a glass which are to be expected in working manipulations of different kinds. They further orient on the time periods during which special glasses of different composition run through a certain interval of viscosities. In the language of the glass makers, this means whether they behave as "long" or "short" glasses during the unavoidable cooling occurring during the manipulation. The difference in temperature between the surface and the interior increases rapidly to a maximum during the early stages of cooling (Fig. 14), and then slowly decreases to zero. These differences are markedly greater in the colored than in the colorless glasses, particularly in a narrow layer at the surface (of only 0.1" thickness), because of the greater emissivity of the colored glass, and at the same time, because of its selective absorption. The corresponding big differences of viscosity of the layers near the surface of colored glass bodies during cooling brings about the well-known rapid setting and the formation of a "skin" during the working manipulations.

On the other hand, the continued experiments of Halle and Turner[22] on the "diathermancy," i.e. the temperature drop in degree Celsius per inch depth in the glass, have a direct importance for the practical problems of heat transfer through the bath. The wall effects in the temperature distribution, which are so difficult in the strict mathematical discussion of these problems, are directly determined by experiments with a model furnace tank. It is valuable to know that in the heat balance of such a model furnace the overall transmissions in colorless glass baths may be approximately 60 per cent, but 49



per cent for amber, and only 37 per cent for dark-green glass. These data were obtained for a constant heat input measured in the gas consumption of 12 cubic feet per minute; the temperatures developed in the center of the glass surface being 1400°C., 1435°C., and 1462°C., respectively. In BTU units the heat transmitted per sq. ft. per inch depth per minute was 73; 60 and 45 BTU, respectively. We have no possibility to discuss here more in detail also, experiments concerning the effects of the iron contents on the transmissivity by "fictive conduction" or "diathermancy"(*); in general, the results of Halle and Turner entirely confirm the theoretical conclusions from the work of the German authors. It is noteworthy that the higher surface temperature of the dark-colored, FeO-rich glass melts also strongly affects the corrosion phenomena on the refractory walls of the tank, as a direct consequence of the increase in the absorption of radiation and the following increase in temperature on the surface layers of the glass bath. In sum, the conclusion is important that the temperature gradient conditions in the depths of glass baths of an industrial tank furnace are related to those in the model furnaces by a linear-controlled ratio, and that it is really possible to make conclusions on the conditions in a large-sized industrial tank melt from laboratory measurements in such a model tank. In addition, it is highly interesting that the results of Halle and Turner also are in agreement with C. E. Gould's[24] equation $T=T_o(1-At^n)$ which concerns the temperature in glass baths, in a depth of t, as a function of the surface temperature T_o, and two constants, A and n, which are related to the iron content of the glass in question. The conclusion is important that for shallow tanks the average gradient is larger than for deep tanks.

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24. ibidem *31*. 1947. 213-217.

(*) That this word used by Halle and Turner is not quite correct was shown by F. W. Preston, Journ. Soc. Glass Technol. *31*. 1947. 134-140; it means for those authors temperature differences.

CALUMITE...
a two-way help to increased profits.

Directly and indirectly, Calumite is helping manufacturers of amber ware to increase their profits.

From the production viewpoint, Calumite insures greater glass stability, easier melting and increased production. Added values are found in diminished superstructure attack and stone loss, considerably reduced volatile attack and batch carry-out and longer checker life and furnace efficiency, all *directly* aiding in improving profits.

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The Calumite Co.
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Research Digest . . .
(*Continued from page* 589)

process of ion-exchange, since in the extract it is unaccompanied by the number of Si^{4+} that result if network breakdown occurs. Hence, if the normal modifying cation/Si^{4+} ratio (as represented by the original glass) is subtracted from the modifying cation/Si^{4+} as represented by the extract, the remainder represents the number of modifying cations that are extracted fundamentally by the process of ion exchange.

The foregoing reasoning naturally will not apply to extracts containing solid material that has been separated from the glass by mechanical means. It is possible, however, that this theory would be valid if the solids were separated from the glass by chemical action and if they were taken into account in the analysis of the extract.

Illustrating this theoretical approach a plot of "excess" alkali ions against total alkali in the glasses indicates the relative tendency of the mixed-alkali glasses toward ion exchange when they are subjected to attack by distilled water for four hours at 90° C. The implication is that ion exchange is more predominant than network breakdown in all the glasses and it is more predominant for the end members than for the mixed-alkali members. For the 18 per cent K_2O, 0 per cent Na_2O glass, N = 20 for K^+; i.e., twenty potassium ions appear in the extract unaccompanied by the number of Si^{4+} to be expected if network breakdown were predominant. For the 18 per cent Na_2O, 0 per cent K_2O glass, N = 37 for Na^+, i.e., thirty-seven sodium ions appear in the extract unaccompanied by the number of Si^{4+} to be expected if network breakdown were predominant. The least number of total "excess" alkali ions (eleven) occurs for a glass containing approximately 11 per cent K_2O and 7 per cent Na_2O.

The "excess" ion curve for Ca^{++} is of interest. Here, N with respect to Ca^{++} is close to unity for all glasses and this value is *not* appreciably affected by the changing ratios of sodium and potassium. The implication is that the dominant mechanism for removal of Ca^{++} in such glasses is network breakdown rather than ion exchange.

It is also indicated that the degree of ion-exchange reaction for each of the alkali ions K and Na (considered separately) increases as the alkali content of the glass increases and that any minimum possibly may be interpreted as no more than the algebraic sum of the separate effects. Such an interpretation leaves open for further study the consideration, on structural grounds, of why certain ratios of alkali ions are apparently more resistant to removal by an ion-exchange mechanism than others.

AMERICAN POTASH & CHEMICALS APPOINTMENTS

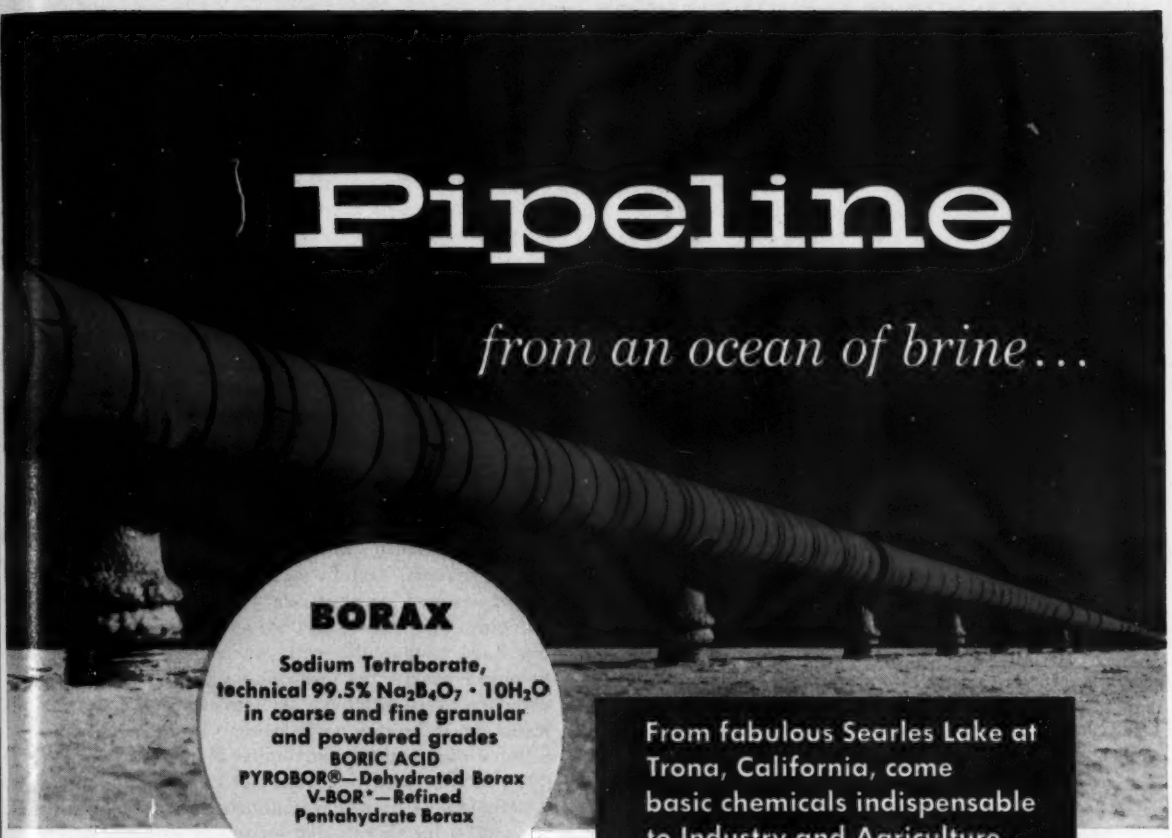
Henry De Armond has been appointed assistant to the company treasurer at the American Potash & Chemical Corporation's Los Angeles headquarters.

Prior to joining the company, De Armond was with Hydro-Aire, Inc., of Burbank, California.

Chester R. Beam, formerly an inorganic chemist with the United States Bureau of Mines has joined American Potash & Chemical Corporation as a research engineer at the main plant at Trona, California.

Pipeline

from an ocean of brine...



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Vendor Consumer Relations . . .

(*Continued from page* 574)

to the quality of the end product of our customers and of classifying all the quality characteristics into three or four groups, such as critical, major, minor and non-classified characteristics. The problem here was to consider all of the factors which affect the quality and price of the end product into which the part goes. I can still remember one of our first meetings at which we asked our customer to classify all defects in the order of importance. We soon discovered that not only was our conception of what is of major importance not entirely correct, but also within our customer's organization there were differences of opinion. What developed from this one meeting was the realization that it was extremely important to define what our customer's needs were. Unless this could be done, no matter how good a quality control program we had in our plants, it would not be sufficient to assure the best quality possible.

Closely related to specifications are the methods of inspection and gaging. We discovered that many of our customers did not have any gages or any duplicate limiting samples for visual defects by which our product could be inspected in order to determine its conformance to specifications. To arrive at similar answers on the quality of any material and thus eliminate most of the errors in quality judgment at both ends of the line, a program was initiated whereby (1) duplicate visual samples and gages were supplied to many of our customers, and (2) identical or closely similar inspection systems were agreed upon.

The final step was the establishment of tentative acceptable quality levels. For the first time in our industry, we began introducing this quality level concept, that is, one that was acceptable to our customers and one that was attainable by Corning Glass Works. Setting such levels took into account such things as parts value, rework and scrap costs and effect of various quality levels on the quality of the end product. Here again, a round-table talk between us and our customers established what was best for both of us. However, this concept was not adopted overnight, although it is now being looked upon with more and more favor. There can be little doubt that this concept of purchasing will spread rapidly as it becomes better understood.

This quality level concept recognizes that we seldom get perfection from any person, machine, or company. Those of us who have had experience with 100 per cent inspection recognize that such inspection is approximately 85 per cent efficient. We have, therefore, accepted a calculated risk of a certain percentage of defectives, and an acceptable quality level (AQL) for a product merely places on the record the recognition of this calculated risk. The sooner we recognize this fact the sooner we can start being realistic about it and act accordingly. The realistic approach seems to be to set up the quality level desired as part of the purchase agreement and, therefore, it seems to belong on, or be part of, the purchase contract between vendor and purchaser.

Although our customers as yet have no purchase contracts containing this AQL concept, our missionary work to date has paved the way for its possible inclusion in the future.

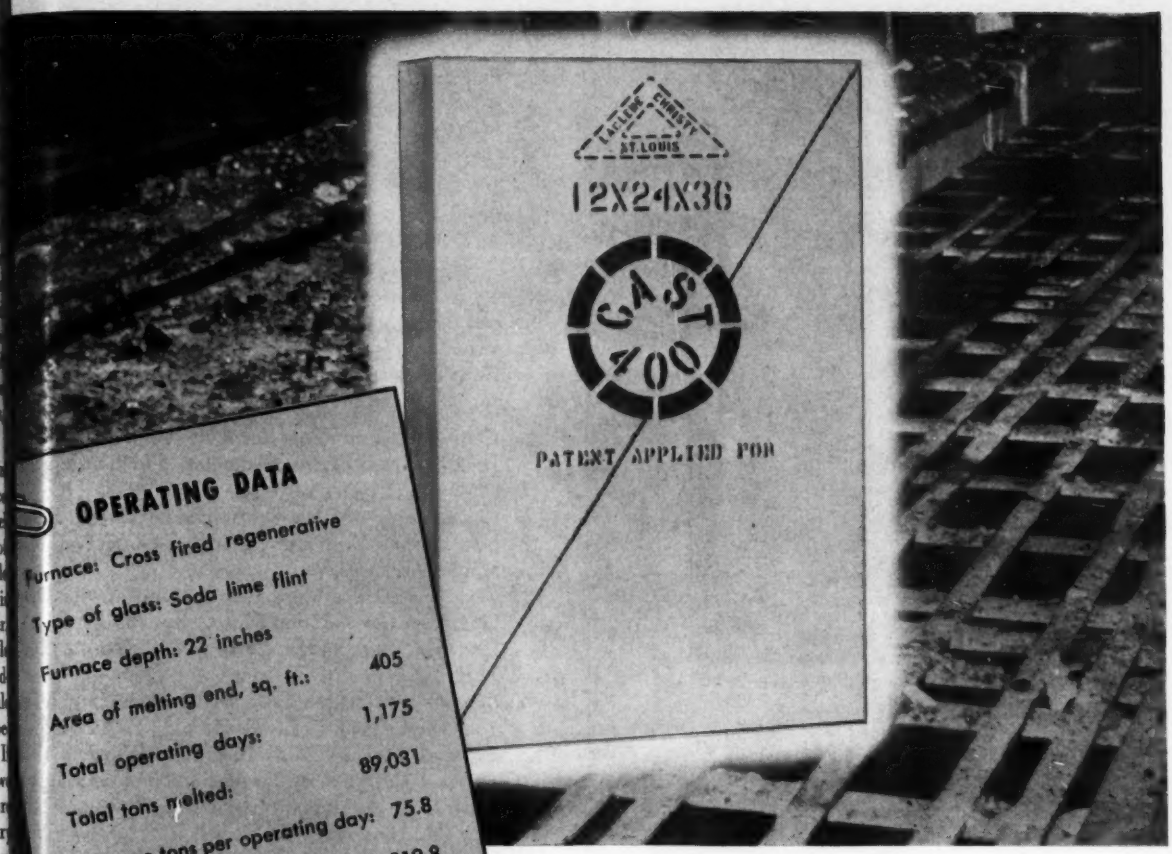
What we have done so far, however, is to enter into some tentative "acceptance sampling plan" agreement with several of our major customers which define on a scientific basis the terms of accepting or rejection on product when it is received in their plants. Our first such agreement was entered around 1947 and, I am happy to say, it is still in operation, although changes have been made since then, especially in the classification of defects and in the quality levels. These were necessary as we obtained more and more experience with this type of concept along with our establishing a firmer basis as to what is of importance to the quality of the end product. Such plans have enabled us to discuss with our customers more freely any problems that arose, with both our customers and we having complete faith and confidence in each other. This alone has made it possible for us to enter the third phase of our program, that is, "*vendor certification.*"

The entire aim of "*vendor certification*" is a reduction of the incoming material inspection load without sacrifice of quality assurance. At the beginning, this quality level concept entailed inspection of every shipment by both of us, as vendors, and by our customers. This is double inspection and perhaps our customers feel that this is the only way they could safeguard quality. However our hope is that ultimately our customers will be able to reduce greatly the inspection and testing of our product. We even anticipate the day when this large scale incoming inspection and testing can be abandoned because we all realize that double inspection is costly. If the relations with our customers are sound and if we have complete faith and confidence in each other, there is no need for this double inspection on each and every shipment. Only a check here and there would be necessary to make sure that some gross error has not been made in supplying the type of product designed and to be sure that no major slip has occurred in the quality.

At present our "*vendor certification*" program calls for only a statement by us indicating that we have a *statistical quality control program* in operation in our plant and that our products are tested and inspected to meet their respective specification requirements and the agreed upon acceptable quality levels. Perhaps we may have to go further than this and supply to our customers either the results of our outgoing inspection or information on our process average. This could be either in the form of a statement of fact, a control chart, or a histogram, so that the customer can evaluate adequately the calculated risk inherent in the sampling plan. Various methods are being studied, and the advantages and disadvantages of each will be discussed in our forthcoming customer quality meetings before any final decision is reached. In this way, we feel that our present excellent vendor-consumer relations will be further strengthened.

Summarizing, Corning Glass Works as a vendor has many responsibilities for quality, which definitely can affect vendor-consumer relations. We realize that unless we do something about the quality of the materials and parts which we process and supply to our customers that they in turn cannot produce a top-quality end product. We have a responsibility not only to make sure that each of our plants has a *statistical quality control program* in operation, but to make sure that our product is

(*Continued on page* 605



OPERATING DATA

Furnace: Cross fired regenerative	
Type of glass: Soda lime flint	
Furnace depth: 22 inches	
Area of melting end, sq. ft.:	405
Total operating days:	1,175
Total tons melted:	89,031
Average tons per operating day:	75.8
Tons per sq. ft. of melt end:	219.8
Fuel: Natural gas	

LACLEDE-CHRISTY Cast 400 Block sets over 3½ year record!

- **Cast 400 helps set record campaign for leading glass producer —3 years, 7 months, 11 days**
- **219.8 tons per sq. ft. of melting end**
- **Average rate of 1 ton to each 5.34 sq. ft. of melting end hearth**

This soda lime glass campaign reflects superiority in glass-making —and also the superior qualities of Laclede-Christy Cast 400 Bottom Block. The campaign recently was concluded in a moderate sized tank with a 22 in. metal depth.

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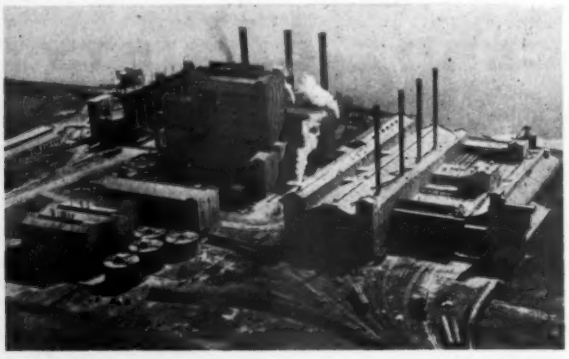
Milestones in Glass Progress

PHOTO COURTESY THE METROPOLITAN MUSEUM OF ART

50 B.C. Flat glass, in some form, has existed from the earliest times. Only in the past few centuries, however, has it been manufactured in quantity and at a cost that permits general use. A rabbit, mushroom, and lizard are shown in the above mosaic of glass cubes, made during the first century B.C.



1890 Michigan Alkali Company, now a division of Wyandotte Chemicals Corporation (North Plant, above), was founded by Captain J. B. Ford to supply Soda Ash to the glass industry. Wyandotte has grown up with glass. Today, as in the past, it is a working partner, supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

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CHEMICALS

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Founded by a Glassmaker to Serve the Glass Industry

SIXTEENTH CONFERENCE ON GLASS PROBLEMS

The Sixteenth Conference on Glass Problems will b held at the University of Illinois, Room 314, Illini Unio Bldg., Urbana, Illinois, Thursday and Friday, Decembe 1 and 2, 1955. Any questions relating to the Conferenc should be directed to F. V. Tooley, Professor of Glas Technology, Dept. of Ceramic Engineering, University o Illinois, Urbana, Illinois. The program will compris three one-half day sessions. Both sessions on Thursda will be devoted to the subject of convection and flow cur rents and temperature conditioning as factors in the glas preparation process. On Friday morning, three paper on subjects of considerable current interest will be heard The program to be presented is as follows:

(1) Conditioning of Glass for Plate Manufacture. W H. Danks and J. A. Slaughter, Pittsburgh Plat Glass Co., Crystal City, Missouri.

(2) Conditioning of Glass for Window Glass Manufac ture. Henry E. Walker, Harding Glass Co., Fort Smith, Arkansas.

(3) Flow and Temperature Conditioning of Glass fo Container Glass Manufacture. Roy S. Arrandale Thatcher Glass Manufacturing Co., Elmira, New York.

(4) Comparative Tracer Tests on Container and Win dow Glass Tanks. F. L. Bishop, Kimble Glass Division, Owens-Illinois Glass Co., Toledo, Ohio

(5) Thermal Currents in the Manufacture of Colored Glasses. R. W. Hopkins and W. H. Manring, Calu mite Co., Hamilton, Ohio.

(6) Electrodes as Tools in Convection Current Control Larry Penberthy, Penberthy Electromelt Co., Inc. Seattle, Washington.

(7) The Effect of Thermal Currents on Refractories Ed Humphrey, Corhart Refractories Co., Louis ville, Ky.

(8) Theory and Practice Concerning the Use of Minor Constituents in Glass. R. M. Wiker, Corning Glass Works, Corning, N. Y.

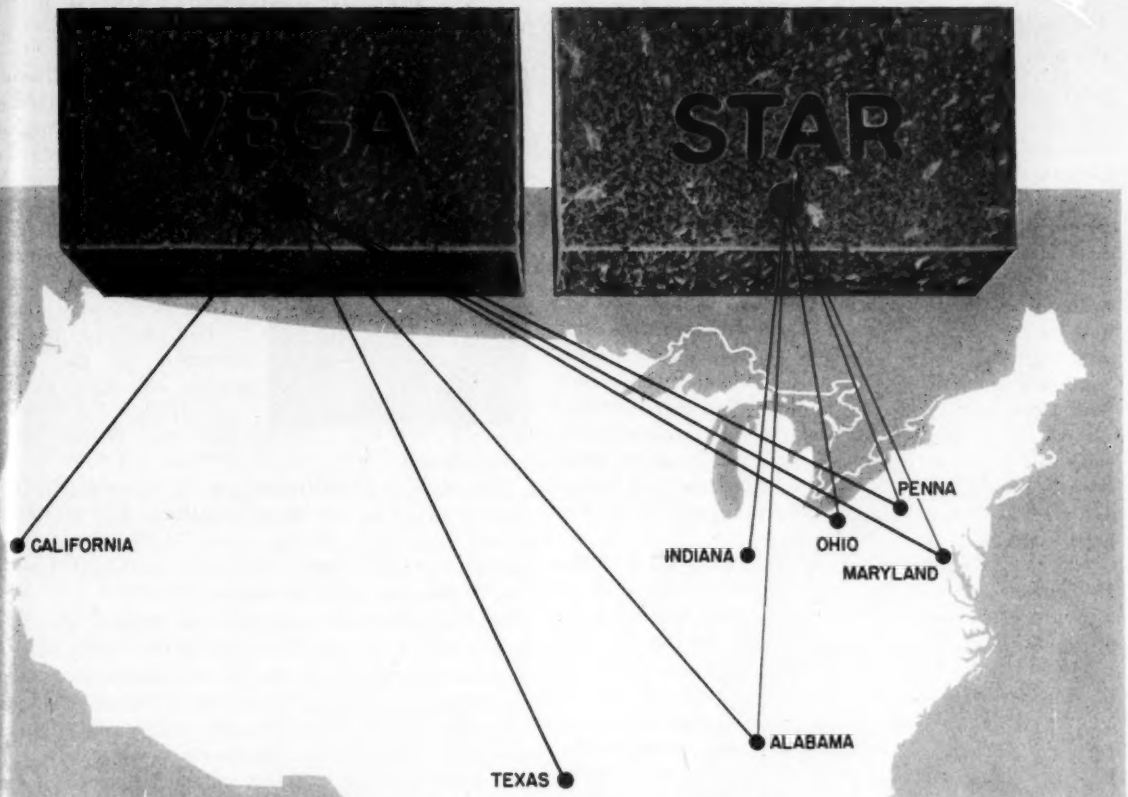
(9) Economics of Glass Plant Building. Morton Cressy Hartford Empire Co., Div. of Emhart Mfg. Co. Hartford, Conn.

(10) Progress in the use of Silicones in the Glass In dustry. John Stapp, Linde Air Products Co., Sili cone Div., Indianapolis, Indiana.

PLANS FOR NEW FIBERGLAS PLANT

Owens-Corning Fiberglas Corporation announced plans to build a plant in New Jersey to be devoted chiefly to the manufacture of Fiberglas insulations, noise control prod ucts and other building materials. The new plant will be built on a 120-acre site, on the New Jersey Turnpike seven miles southeast of Camden. The site is on the east side of the turnpike near Route 30 and adjacent to the Pennsylvania-Reading Seashore Railroad. It is divided nearly equally between Barrington and Magnolia boroughs.

Construction of the new plant will begin this winter and it is hoped to have production started by next fall. Plant employment is expected to be about 250 initially and to reach about 1,000 when the plant is completed and in full operation.



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VEGA BOND—Smooth-working VEGA BOND contributes materially to longer furnace life when used for laying silica brick. It corresponds to VEGA super-duty silica brick in refractoriness, chemical composition and thermal expansion.

STARBOND — Higher in refractoriness than the usual silica mortars, STARBOND matches STAR silica brick, and for average operating conditions is used with splendid results. Its excellent plasticity lends itself to thin, impervious joints.

These two superior silica brick now are made at various Harbison-Walker plants as shown on the map. Shipments from these advantageous locations provide important savings in transportation time and cost. Both STAR, the standard of quality in the glass industry for more than half a century, and VEGA, the original super-duty silica refractory, are manufactured under rigid quality control.

Note the features that insure tight, durable crowns and walls.

- The excellent workmanship makes possible tight-fitting, highly impervious brickwork.
- The low content of alumina, titania and alkalies accounts for their high refractoriness and resistance to fluxing.
- Low porosity, stability of volume and high temperature strength are important characteristics of these brands.

VEGA fulfills the need for a refractory that permits higher furnace temperatures with increased tonnage output.

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Teaching and Research in Great Britain . . .

(*Continued from page* 583)

Belgium and Germany, as well as in England, culminating in the First International Congress on Glass in Venice in 1933 and the formation of the permanent organization entitled The International Commission on Glass. Dr. Turner the President, Dr. Ing. H. Maurach (Germany) Secretary and Dr. J. C. Hostetter (U.S.A.) constituting the Executive Committee.

The Glass Department and the Society did great work with slender resources, being sustained by hardworking and enthusiastic supporters. They demonstrated what virile and enthusiastic service to an ideal can accomplish with small financial resources. All who came in contact with them were caught up in the enthusiasm they displayed. I made my first acquaintance with these organizations and their members late in 1922 and for many years have found in them a sphere of congenial and happy work. I believe many others have enjoyed a similar experience.

However, the continued expansion of the work of the Department has from time to time led to a review of its activities and resources. The new scheme will bring in a substantial financial contribution from the Government.

While those long associated with the Delegacy look on the closing down with some regret, all will continue to support those charged with the responsibilities of the two organizations, so that they not only maintain the high traditions of their parent but bring added fame to the industry they serve and provide those who follow my generation with opportunities for service.

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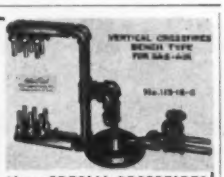

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GEORGE BALL DIES AT 92

On October 22, 1955, George Alexander Ball, last of six brothers died at the age of 92. He was born on a farm near Greensburg, Ohio, November 5, 1862, a son of Lucius Stiles Ball and Marie P. Bingham Ball. The family was residing in Canandaigua, N. Y., when George A. Ball received his early education in the public schools and later attended Canandaigua Academy, as did four of his brothers and one of two sisters before him.

The family was still residing in Canandaigua in 1880, when Edmund B. and Frank C. Ball, in their early 20's, started a business in Buffalo out of which came a closely-knit team of five brothers who gained nationwide recognition in the glass container industy.

Mr. Ball and his brothers began making glass containers of a kind in 1882. During that particular era, homes were being illuminated by the then comparatively new kerosene lamp. Edison had invented his electric light four years earlier but only a few people in and around the larger cities had access to electricity. The Ball brothers made a glass container, encased it in a sheet metal jacket and housewives of that day used the product for the household handling of kerosene.

As the Buffalo enterprise prospered and grew, the three brothers, William C., Lucius L., and George Ball, joined the business and finally moved to Buffalo with their widowed mother.

A few years later, the company broadened its line of glassware to include the manufacture of the Mason fruit jar and continued to manufacture in Buffalo until 1887 when the brothers moved their operation to Muncie, Indiana.

Through the 68 years that followed the move to Muncie, the company had expanded to include the manufacture of metal, rubber and paper products in addition to glass containers.

In 1944, Mr. Ball became president of his firm at the age of 82. After three years he turned the post over to a nephew, Edmund F. Ball and became chairman of the board.

In contradiction to his advanced years, Mr. Ball remained thoroughly active in all affairs of his company as well as having many varied philanthropic interests. Among his philanthropies were a foundation for the building of Indiana's educational and hospital facilities.

In 1935 the industrialist was catapulted into national prominence as a result of a business venture in which he became a joint owner of a railway system built by the late O. P. and M. J. Van Sweringen.

Mr. Ball was a member of the board of trustees of Indiana University from 1919 to 1938, serving as president of the board from 1936 to 1938 and had been a director of the Indiana University (scholarship foundation) since its establishment in 1936. He was a former

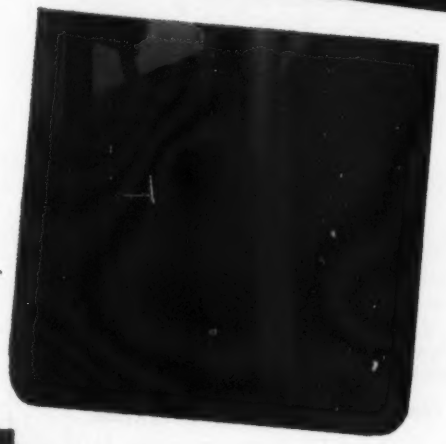
(*Continued on page* 608)

WE SLICE BOTTLES TO MAKE SURE COLORS "FIT"

Unless an ACL color "fits" a glass bottle properly, harmful stress can make the container unsafe for pressure beverages. To prevent such stress, Drakenfeld technologists use the most modern laboratory equipment and facilities to measure and study coefficients of expansion.

Even before an ACL color is created from a glass flux, the expansion compatibility of the flux itself is checked against that of a ring section from a bottle like that on which the color will ultimately be fired. Every color developed undergoes similar tests. After sample bottles are decorated, ring sections cut from them are studied under a polarizing microscope to make certain no strains weaken the bottle.

Such thoroughness is indicative of what Drakenfeld technologists do to solve your glass decorating problems. Drakenfeld ACL Enamels are made to "fit"—and give you the advantages of improved alkali resistance, better workability, greater acid, sulphide, chip-and-scratch resistance, and lower firing temperatures. Samples are yours on request. Write today.



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Seventh Iron Clinic . . .

(*Continued from page* 582)

in connection with the lubricant discussion, Mr. Flatter introduced Mr. James Brakeman, president of Lubracrome Corporation, Lansing, Michigan. Mr. Brakeman discussed the Lubracrome process using actual case histories compiled by several different glass companies. The results of production runs were discussed pro and con for the benefit of those who have not used Lubracrome plating on their mold equipment. Of the many interested in the elimination of black specking in glassware. Other principal advantages claimed were increased life of mold equipment, less cleaning and down time on machines.

Mr. Brakeman called upon Overmyer's Vernon Ruble and Wilmer Welch, who have done most of the glass mold work in connection with Lubracrome, to discuss their experiences during the past year and answer questions presented to them by the assembled glassmen.

Overmyer's Earl Flatter, during the open discussion agreed that, while Lubracrome has not been generally accepted by the industry, they have had some excellent results with Lubracrome and that they chrome a large percentage of their plungers and that it is used in special instances on molds. Mr. Flatter also stated that they have chromed a very large number of shear-blades which, according to reports, have given excellent performance mechanically and in increased life.

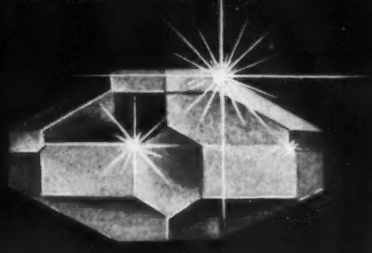
At the conclusion of the Lubracrome discussion, Mr. Brakeman digressed to present a new method of removing carbon and sludge from mold equipment. The method has been termed the "immersion process" and has been used successfully by other industries where carbon deposits and contaminants present cleaning problems. Principals of the process were discussed at length and compared to cleaning methods now in use by the glass industry. Many companies using vapor blast equipment prefer the immersion process since it avoids disturbance of the base metal.

William Clark, vice president of Wall Colmonoy Corporation, Detroit, Michigan, offered additional information concerning the use of Colmonoy on glass mold equipment. Mr. Clark discussed the applications of Colmonoy and the progress during the five year period of its use in the glass industry. The most significant advance appeared to be the use of Colmonoy castings as inserts in the manufacture of two part neck rings and thimbles. Mr. Clark described the metallurgical properties as non-magnetic nickel-chromium-boron alloy. The desirable characteristics provides good abrasion, impact and galling resistance and excellent corrosion resistance, red hardness and weldability. Actual tests conducted in several glass factories conclusively prove that a Colmonoy casted insert will outlast five units of conventional cast iron construction. In conclusion, Mr. Clark assured the group that Wall Colmonoy Corporation would continue to expand the range of applications to all problem areas through their continuing research program.

The next speaker, S. J. Singer, of Specialty Products Company, Jersey City, New Jersey, discussed the use of silicones as a lubricant. Mr. Singer has been working with the glass industry in connection with their smoke control problem, which has been extremely critical in certain industrial areas and especially on the West Coast where smog conditions are at their worst. Some manu-

(*Continued on page* 604)

magic crystal...



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Sheer magic in the 17th Century—commonplace today—when magic crystals of BORAX first imparted to glass a desirable resistance to thermal and mechanical shock, and later made possible the well-known Jena Glass. Many centuries earlier, ancient Persia had revolutionized her glazing by means of the selfsame magic crystal. Down through the ages into present-day usage, the four valuable properties of B_2O_3 have benefited the Ceramic and Glass Industry—(1) by improved fluxing of the batch (2) decreased coefficient of expansion (3) increased resistance to corrosion (4) influence on the refractive index. Ask our technical staff how borates may benefit you.

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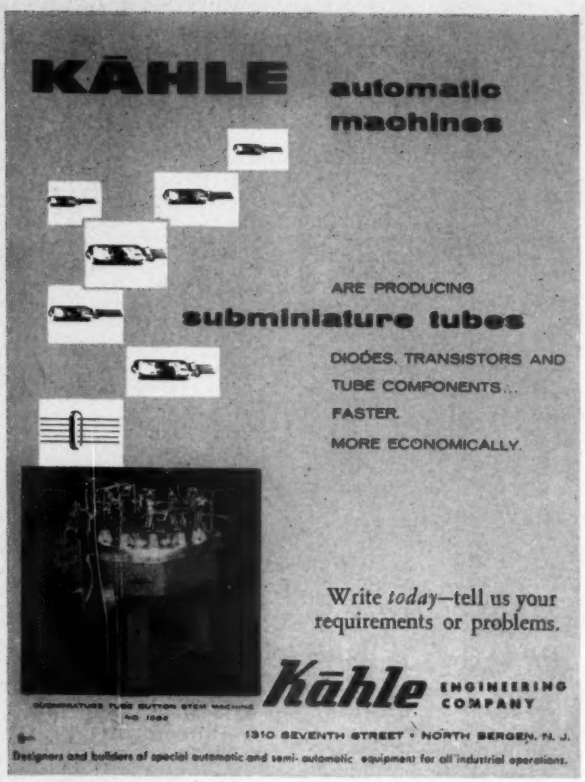

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233)

Of THE GLASS INDUSTRY, published monthly at Bristol, Conn., October 1, 1955.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, John T. Ogden, 55 West 42nd Street, New York 36, N. Y.; Editor, Cyril B. Delgado, 55 West 42nd Street, New York 36, N. Y.; Managing Editor, None; Business Manager, Cyril B. Delgado, 55 West 42nd Street, New York 36, N. Y.

2. The owner is: Ogden Publishing Company, 55 West 42nd Street, New York 36, N. Y.; John T. Ogden, 55 West 42nd Street, New York 36, N. Y.; Katherine Waller Ogden, 55 West 42nd Street, New York 36, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

(Signed)
JOHN T. OGDEN, *Publisher.*

Sworn to and subscribed before me this 23rd day of September, 1955.

David M. Cohen
Notary Public in the State of New York
No. 24-5736200
Qualified in Kings County, Cert. Filed with New York Co. and Kings Co. Clerk and Reg.
Commission Expires March 30, 1956

Seventh Iron Clinic

(*Continued from page* 602)

facturers have used silicones suspended in water as a lubricant. The use of silicones not only substantially reduces the smoke but provides cleaner mold equipment during the production run. There is also less carbon built up which reacts with other favorable characteristics insuring a better quality of glassware.

Mr. Singer, in referring to his impressions gained from his personal contact with the glass industry, stated that "the smoke problem appears to be universal, with each glass manufacturer working independently of the other to arrive at some solution." He suggested that perhaps a combined effort on the part of the glass industry would result in a definite solution with less expense to each participating manufacturer.

The last speaker of the morning was Dr. Arthur B. MacTaggart, technical director of Electrocleaning, Incorporated, Cleveland, Ohio. A brochure containing a comprehensive explanation of the electrocleaning process was distributed to each person to assist them in the discussion which followed. The brochure contained charts, pictures and other pertinent data to illustrate the advantages of the cleaning method. Dr. MacTaggart told the group that his information had been compiled in a pilot plant of a prominent glass manufacturer and through laboratory research.

Dr. MacTaggart broadly discussed this new automatic electrolytic cleaning process for glass molds. It was stated that no metal was removed from the mold during the cleaning process. It was further claimed, that in its first production tests, in a glass container plant, savings of over 30 per cent were indicated in cleaning cost.

At the conclusion of the Clinic session, the group reassembled for lunch at the Beeson Club House, following which were organized group tours of the Overmyer plant.

In the afternoon, golf occupied a number of those attending the meeting. Finally, the annual banquet provided conviviality and an excellent menu. Max Hawkins, Overmyer sales manager, officiated as master of ceremonies and awarded many attractive golf prizes.

Left to right: Charles Lindsey, Carr-Lowrey; Roy Newell, Glass Containers; Lowell Roesner, Overmyer Mould Co.; Roy Ball, Anchor Hocking; Roy Deible, Knox Glass.

Vendor-Consumer Relations . . .
(*Continued from page* 575)

tested and inspected so that our customers can be assured of its top quality. To further assist our customers in reducing their incoming inspection costs, we must in some form or other certify the quality of our product and thus enter into *quality level certification agreements*. Such agreements establish quality as a mutual responsibility of both the consumer and the supplier. It sets forth in realistic terms the means by which the highest quality on incoming parts may be achieved, a level of quality which is consistent both with the ability of known manufacturing processes and the needs of Corning Glass Works' customers. It is another tool to be used in building up the desired friendly vendor-consumer relations.

RALPH A. LIND DIES AT 58

Ralph A. Lind, labor relations director of the Glass Container Manufacturers Institute, Inc., 99 Park Avenue, New York, died enroute to New York by train from Lancaster, Ohio, on Wednesday, October 26th, 1955, at the age of 58.

Mr. Lind joined GCMI in July of 1954. For the preceding 17 years he was director of the industrial and labor relations consulting department of the New York management engineering firm of Stevenson, Jordan & Harrison, Inc., where he served as consultant on labor relations to GCMI as well as many large corporations throughout the country.

Prior to that, Mr. Lind was regional director of the National Labor Relations Board in the Ohio-Indiana area where he achieved national prominence for having effected settlements in many major labor disputes.

Prominent in Masonic circles, Mr. Lind was elected a Jester last year. His clubs included the Cleveland Athletic and the New York Athletic.

Mr. Lind is survived by his widow, Mrs. Helen Hart Lind, a son, Ralph A. Lind, Jr., a daughter, Mrs. Selwyn A. Stark of Indianapolis, Indiana, and three grandchildren.

NEW $1,500,000 RESEARCH CENTER PLANNED

A new $1,500,000 research, development and headquarters building, "dedicated to the American housewife," will be constructed at Towson, Maryland, by Crown Cork & Seal Company, president Russel Gowans announced.

The research and development staff will engage in extensive experiments dealing with new and improved methods for packaging foods and beverages. The combination two- and three-story structure, fourth major expansion of Crown facilities within a year, will contain chemical, metallurgical, physics and analytical laboratories, design and drafting departments, a technical library and experimental machine shop. Actual construction will begin next February.

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STAUFFER, CONSOLIDATED CHEMICALS DIRECTORS APPROVE MERGER PLAN

In a joint statement, the Stauffer Chemical Company and Consolidated Chemical Industries, Inc., announced that agreement in principle had been reached on a plan of merger of Consolidated into Stauffer. The plan was approved unanimously by the boards of directors of both companies at special meetings held September 19th and it will be submitted to the stockholders of both companies for their approval.

Speaking for their respective boards of directors, Christian de Guigne, chairman of the board of Stauffer and George L. Bond, president of Consolidated, said that the plan provides for an exchange of 3¼ shares of Stauffer common stock for each share of Consolidated Class A participating preference stock, excluding the shares of Consolidated owned by Stauffer. If the merger is completed, 698,038 shares of Stauffer common stock will be issued in exchange for 214,781 shares of the Consolidated Class A stock. There are presently outstanding 2,350,240 shares of Stauffer common stock.

Mr. de Guigne also announced that the Stauffer board increased the quarterly dividend payable on the Stauffer common to 40c a share, payable December 1st to stockholders of record on November 17th.

Total assets of the combined companies will be $120,000,000. The Consolidated Chemical Industries operations will be carried on under the name of "Consolidated Chemical Industries Division of Stauffer Chemical Company." No significant changes affecting personnel in either company are contemplated.

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MECHANICAL ENGINEER WANTED

An excellent opportunity is afforded a mechanical engineer with proper qualifications by a southwestern glass company manufacturing glass containers. Glass-house experience desirable but not absolutely necessary. Experience in electrical, ceramic, industrial or chemical engineering also would be helpful. In reply, please give age, family status, complete experience, compensation desired, recent photo or snapshot, etc. Reply to: Box 182, c/o The Glass Industry, 55 West 42 St., New York 36, N. Y.

● Norman K. Russel has been appointed general sales manager of Richard C. Remmey Son Company, Philadelphia, manufacturers of Clay and Silicon Carbide Refractories.

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George Ball . . .

(*Continued from page* 600)

member and chairman of the board of trustees for two Indiana teachers colleges, Ball State Teachers College, Muncie, and Indiana State Teachers College at Terre Haute.

He was chairman of the board of the Merchants National Bank, Muncie and president of the board of trustees of Ball Memorial Hospital, which the Ball Brothers Foundation built and made available in 1929 to the people of Muncie and its vicinity. The hospital was but one of many philanthropies in which he participated.

Mr. Ball held many memberships in clubs and organizations throughout the country, besides holding the directorship of a number of educational and civic institutions.

Surviving are his widow, the former Frances Woodworth and a daughter, Elizabeth.

GLEN WALKER COLE, BOARD VICE CHAIRMAN OF CORNING GLASS WORKS, IS DEAD AT 60

Glen Walker Cole, vice chairman of the board of directors and former president of Corning Glass Works passed away in the Corning hospital on October 18th after a short illness. His age was 60.

Mr. Cole served successfully as superintendent of the Steuben division, company production manager, vice president and general manager of sales and became president of the company in 1941 through 1946, when he became vice chairman. He was a director and vice president of the Pittsburgh-Corning Corporation, vice chairman of the board of Corning Glass Works of Canada, Ltd. and a director of both Corhart Refractories Company and Dow-Corning Corporation.

He is survived by his widow and two daughters, Mrs. Frank Heyniger and Mrs. W. R. Page.

PLANS FOR NEW WINDOW GLASS PLANT

Pittsburgh Plate Glass Company disclosed plans for the construction of a multi-million-dollar window glass producing plant at Decatur, Illinois.

According to David G. Hill, vice president in charge of glass manufacturing, the new plant will be located on an 80-acre site southeast of Decatur. The acreage acquired is farmland.

The new facility will be ultra-modern and will utilize newly developed mechanical and electronic equipment in the manufacture of window or sheet glass. About 250 employees will be required to operate the new plant.

Since World War II, production facilities at existing plants have been increased by more than 80 per cent. With the production capacity planned at Decatur, the company will have more than double the window glass manufacturing it had in 1946, according to Mr. Hill.

Ground will be broken for the plant site early in 1956 and the firm expects to have the plant in full production twelve months later.

● Appointment of C. G. Davison as supervisor cost planning for Pittsburgh Plate Glass Company has been announced by C. R. Fay, vice-president and comptroller for the firm. He succeeds T. G. Coyne who resigned recently.

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